Compressed Air Magazine

Vol. XXXIV, No. X London New York Paris 35 Cents a Copy

OCTOBER, 1929
CIRCULATION THIS ISSUE
30,658 *COPIES*

EXPERT INSPECTORS EXAMINE A NUMBER OF BULBS AT ONE TIME. EVEN THE SMALLEST DEFECTS ARE DETECTED.

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Compressed Air Magazine

NEW YORK · LONDON · PARIS

Principal Offices
Bowling Green Building
No. 11 Broadway
New York.

VOL. XXXIV, No. X OCTOBER, 1929

Glass Bubbles For Incandescent Lamps

Their Share in the Amazing Developments That Are to Be Celebrated by Light's Golden Jubilee

By R. G. SKERRETT

DO you know that a short, charred loop of sewing thread was the corner stone of the magnificent industry that now serves us with electric light and power—an industry that has, today, an invested capital of more than $8,000,000,000? Unbelievable as it may seem, still the foregoing statement is a permissibly picturesque summing up of the truth.

The loop of carbonized thread just referred to formed the filament of the first commercially practicable electric incandescent lamp devised by Thomas Alva Edison 50 years ago this month. That filament and its associate features were the climax of numberless experiments and the exercise of infinite patience on Edison's part in his effort "to subdivide the arc light" and so temper that illuminant that it could be used in the home, in the office, and in the hotel. While Edison did not succeed in subdividing the arc light by making miniature lamps on that principle, still he did produce something comparable and far better suited to the particular service for which it was intended.

Even after Edison had overcome seemingly insuperable obstacles in carbonizing instead of burning up his slender loop of thread so as to get a filament of high enough resistance to become incandescent when interposed in an electric circuit, he had a number of other vitally necessary things to do to turn out a successful electric lamp. He had to place that fragile filament in a glass bulb and to join it with proper electric connections that would be air-tight when the bulb was exhausted by a vacuum pump; and when each and all of these had been accomplished through tireless labor, Edison found himself surrounded by a skeptical group of coworkers in his laboratory at Menlo Park, N. J. They believed that the filament would be quickly reduced to ashes after current was turned on. Only Edison had faith, because only he knew fully the conditions that he had sought to create.

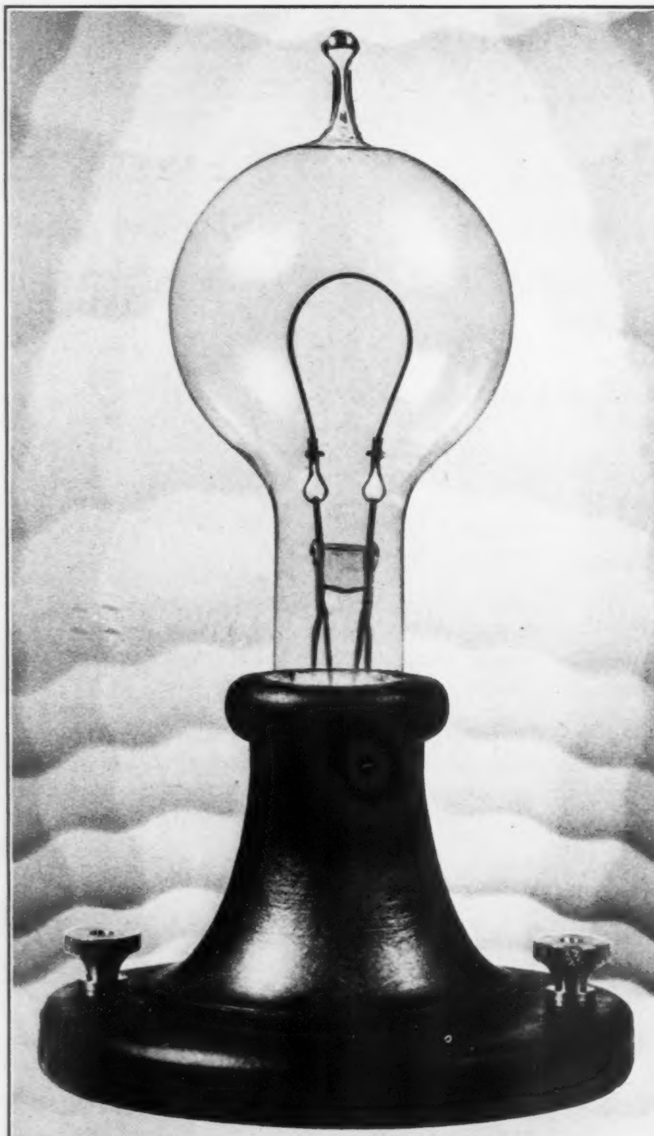
Undismayed by their doubting expressions as they stood around him, Edison gradually increased the strength of the current flowing into his lamp. At first, the filament became a dull red, and from that it glowed brighter and brighter until it reached incandescence

as the maximum strength of the current flowed through the resisting carbon loop. Instead of lasting but a few minutes at most, as some of his associates had prophesied, the lamp burned steadily and brightly for a continuous period of substantially two days! It is that memorable occasion that Light's Golden Jubilee will celebrate during the present month when honoring Edison for the several amazing things he did in order to launch the electric-lighting industry upon its marvelous career of service.

Edison was not the first man to devise an incandescent electric lamp—others preceded him in what might be called the laboratory stage of the art; but to Edison is undoubtedly due full credit for producing an incandescent electric lamp that could be manufactured and sold on a commercial scale. That lamp, however, was merely one unit in a threefold achievement of an unparalleled character. Before that lamp could have any practical value it was also necessary for Edison to invent and to build a unique dynamo that would be capable of furnishing current at a constant voltage and which would operate at an efficiency nearly twice as high as that believed theoretically obtainable by experts and mathematicians! Furthermore, Edison had to originate a previously unheard of system of current distribution—one that would put electric lighting on a basis comparable with the prevailing use of gas for illumination. That is to say, he had to conceive a constant-pressure electrical system that would permit any one or any number of lights on a line being turned off or on without affecting the other lamps in the same circuit. Edison did these astonishing things when electrical engineering was truly in its infancy and when virtually all his needful apparatus and fittings were novelties and had their birth in his extraordinary fertile mind.

It is not our purpose to dwell in detail upon the invention and the evolution of the incandescent lamp—the subject has been and will be exhaustively covered by other publications; but we do want to emphasize that, for a considerable period, the revenue from electric lighting was the only source of income for the companies that started in that business. Later on, current for power purposes was generated and sold when dynamos were constructed capable of furnishing sufficient energy for that service. Even so, the primary object of those machines was to provide current for larger and larger numbers of incandescent lamps. Thus, out of the initial lighting industry grew the present one which supplies energy both for power and illumination. It is this dual public service that represents the enormous investment of more than $8,000,000,000, and which grows at a rate that necessitates the expenditure each year of approximately $900,000,000 additional.

It has been authoritatively stated that the people of the United States spent during 1928 substantially $600,000,000 for lighting by means of incandescent lamps. If the lamps of today were not 4¼ times more efficient than the best of the carbon-filament lamps of 22 years ago—thanks to the wonderful work done in perfecting the tungsten filament, our lighting bill for the past year would have been $2,550,000,000 instead of $600,000,000! So much for a single improvement that has cut down the amount of current needed to produce a given measure of light and which, incidentally, has saved the consumer's pocketbook proportionally—thereby encouraging a still wider use of incandescent bulbs.



Replica of the experimental lamp, demonstrated on October 21, 1879, which proved that Edison had solved the problem of "subdividing the arc light", and which then blazed the way for the evolution and development of a great industry.

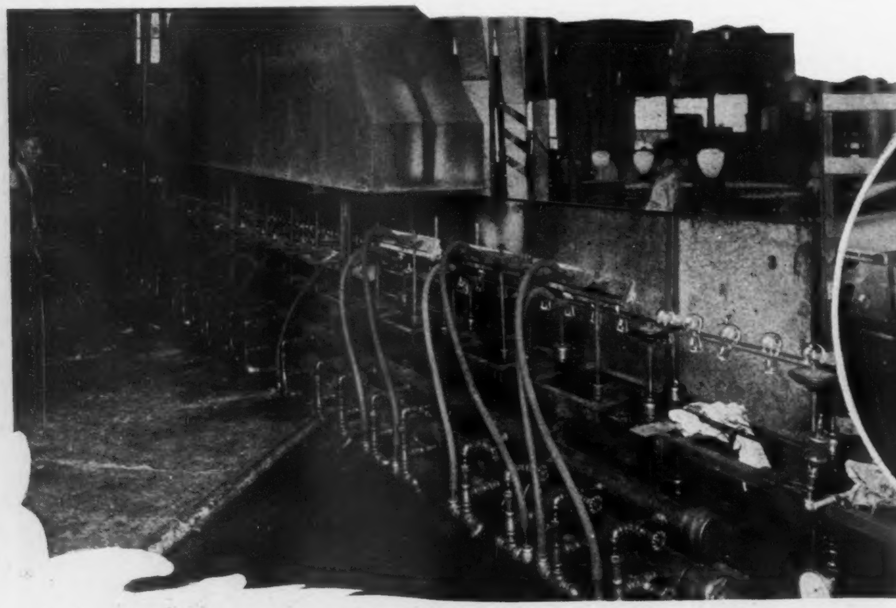
Startling as the foregoing facts and figures are, it is doubtful if most of us yet appreciate what has followed since Edison devised his first successful carbon-filament incandescent lamp. Perhaps we can grasp what we now enjoy if we visualize what would happen if all our electric lights suddenly failed us. According to figures lately made public by the National Electric Light Association, there was sold during the year gone a total of 330,000,000 large incandescent bulbs—as distinguished from miniature lamps; and those large bulbs had a combined potential radiance of 247,500,000,000 lumens or 18,800,000,000 candle power, if gaged by the older standard of illumination. Can you picture what would happen if all those lamps were concentrated, in the sky, above such a city as New York? And, conversely, can you conceive what would be the degree of gloom if those lights were simultaneously turned off?

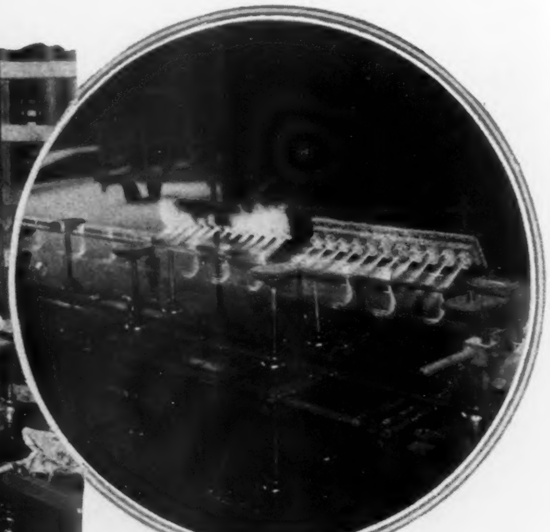
The average intensity of illumination in the form of sunlight over the Metropolis is rated at 3,000 foot-candles; and if all the lamps just mentioned were hung over New York and switched on after dark the resulting brilliancy would equal the noonday glare of the sun intensified several times! And if they were snuffed out, the gloom would be correspondingly deep by contrast. Again, if those lights were arranged so that they would glow at one time over the whole expanse of the United States after nightfall, the illumination would suffice for all of us to see our way plainly about, no matter how black the night! Now we have a better idea of what Edison blazed the way for when he carbonized that bit of sewing thread half a century ago.

Like other experimenters then seeking to devise electric lamps, the first of Edison's enveloping glass chambers were made in two parts that were so joined that it was possible easily to renew a filament. Subsequently, when Edison adopted a thin and high-resistance filament and employed a vacuum to lengthen the life of his carbon loop, it became evident to him that a 2-piece glass chamber would be apt to leak at the joint and impair the essential vacuum. Then it was, with characteristic boldness, that he decided upon a radical structural departure—one that made it impossible to substitute a new filament for a broken one. In short, he fused together the two parts of his glass bulb—making them inseparable, and at the same time announced: "I will make the lamps so long-lived and so cheap that they can be thrown away when the filament burns out." This brings us to

Courtesy, The New York Edison Company

A few spectacular examples of illumination, after nightfall, made possible by the development of the incandescent electric lamp





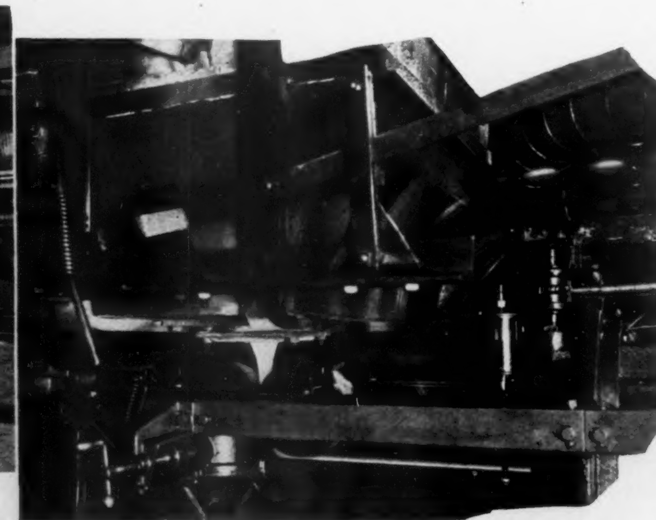
Left—The batteries of burners, using compressed air and butane, that fuse the necks of the bulbs as they come from the automatic blowing machine. Right—Close-up of two groups of burners showing how they play upon the bulbs passing continuously before them on the conveyor.

the story that it is especially our intention to tell here.

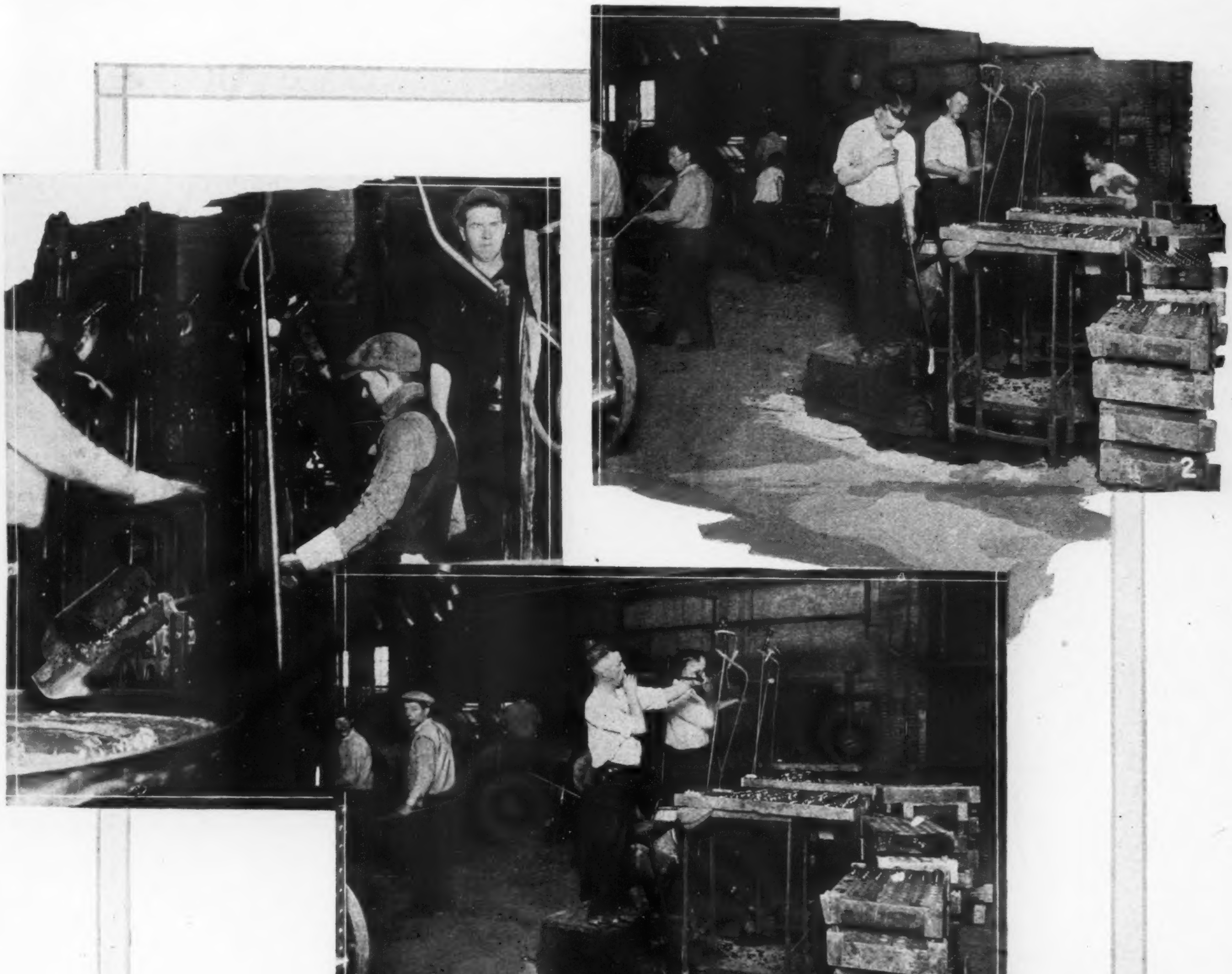
In 1880, Edison called into being an incandescent-lamp factory at Menlo Park; and for a while the bulbs were fashioned there from 1-inch tubing which was heated and shaped to the desired form. But these were relatively heavy affairs and not what the inventor had in mind. What he wanted was little else than a veritable bubble of glass with extremely thin globular walls. The question was where to obtain bulbs of that sort—something previously unknown to glass blowers. In his predicament he turned to his old friends, the Houghtons, who operated the widely known Corning Glass Works, at Corning, N. Y. There, if anywhere, he knew he could find skilled men who possibly might be able to make the kind of bulbs he desired.

Of course, the grimy blowers could make anything Mr. Edison wanted of them in the form of glass! Hadn't they been doing that very thing day in and day out for years? To prove it, each youthful gatherer took from one of the irridescent pots a gather of plastic glass on a blowpipe, which he handed to the bearded blower who rolled the glass into a cylinder on his marver, blew a puff of air into the still yielding mass, and then majestically handed the iron back to the attendant gatherer for reheating in the furnace. Next, the gatherer returned the pipe to the blower who, by skillful manipulation and intermittent blowing, elongated the heavy bubble and finally gave it a pearlike form. It looked not unlike a round-bottomed bottle, and was remote from the delicate thing that Edison sought. After weeks of patient effort and intelligent coöperation on the part of the blowers and their assistants, a thin-walled but rigid bubble of glass was produced; and thus started the hand-blowing of bulbs for Edison's incandescent lamps.

For something like twelve years following 1880, the bulbs made at the Corning Works were "free blown" directly from the glass taken from the furnaces, and their forms and sizes varied somewhat. Success was altogether dependent upon the skill of the blower. These bulbs had to be grouped afterwards agreeably to their forms and sizes. Later on, the globes were hand blown in 2-piece iron molds that were opened to receive the glass and then closed about the bubble before it was distended to conform to the shape of the mold. The use of the mold made it practicable for the blower to turn out a uniform product and to do his work faster. Strange as it may seem, handmade molded bulbs were the only kind available for incandescent lamp for substantially a quarter of a century. At the end of that time, mechanical geniuses had succeeded in devising machines that could

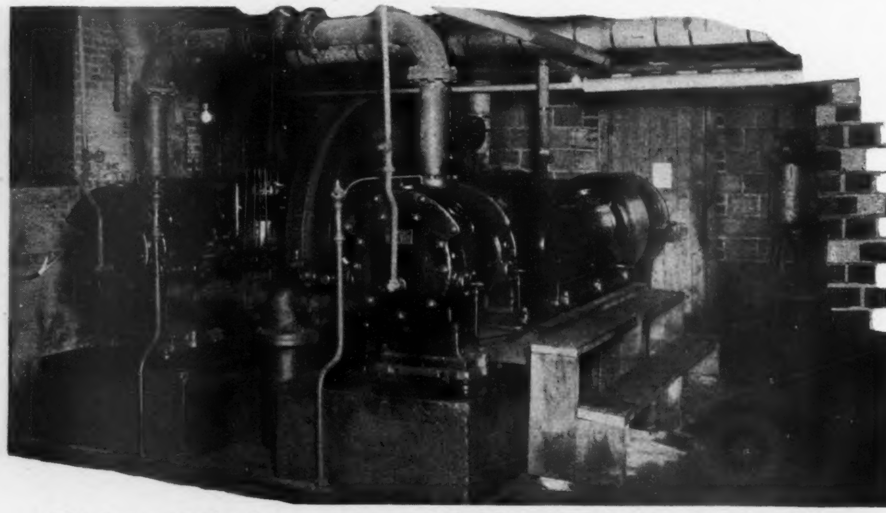


Left—One of the four bulb-blowing machines in the Wellsboro plant of the Corning Glass Works. This machine is capable of making as many as 300 bulbs a minute. Right—Close-up of the feeding end of a bulb-blowing machine, showing the molten glass flowing from the furnace and passing between the wheels that roll it into a ribbon from which the bulbs are automatically blown.



1—Semi-automatic blowing of incandescent bulbs, in which both human hands and machines combine in manipulating and blowing the glass. 2—Hand-blowing of glass bulbs for incandescent electric lamps. The blower has opened the 2-piece mold with his foot preparatory to inserting the plastic glass. 3—Here the blower is seen forming the first bubble of glowing glass. Next he will elongate it and insert it in his foot-operated mold. 4—Some of the numerous sizes and forms of bulbs produced by the Corning Glass Works for electric lamps of different sorts. 5—The largest glass bulb so far blown at the Corning Glass Works. This bulb is for an incandescent electric lamp of 5,000 watts, having the illuminating equivalent of about 64,000 lumens.

blow bulbs—that is, take the molten glass from the furnace in exact quantities; form it into bulbs in a series of mechanically operated split molds; and, finally, deliver the completed bulbs on to an asbestos belt that carried them through an annealing furnace and onward to inspectors, who were the first to handle them. Five years ago, machines of this description were capable of producing, in the course of 24 hours, a total of 50,000 bulbs. A skilled blower, assisted by a gatherer, can make 1,440 bulbs during a shift. Such is the difference between the work of a man and the output of a machine. Much has been achieved in the last two or three years in improving the bulb-blowing machines and in greatly augmenting their rate of production.



This Ingersoll-Rand compressor, capable of supplying 1,200 cubic feet of air per minute, furnishes air for various purposes in the Wellsboro plant of the Corning Glass Works.

Someone will ask: Why blow any bulbs by hand if machines can do the work equally well and a vast deal faster? The answer is: Machines cannot be economically used in making comparatively small lots of bulbs; and part of the business consists of blowing a considerable number of bulbs of special forms and certain colors for particular purposes. Therefore, there is reason for the trained hand worker. All the bulbs blown at the Corning plant of the Corning Glass Works are of hand-made sorts. The men are experts, and one marvels at their dexterity and the certainty with which they handle their blowpipes and open and close their molds by timely pressure upon pedals on the floor of their individual platforms. But as our object is to tell the story of progress, our readers will probably be most interested in learning something about operations in a plant where the bulbs are blown by machinery.

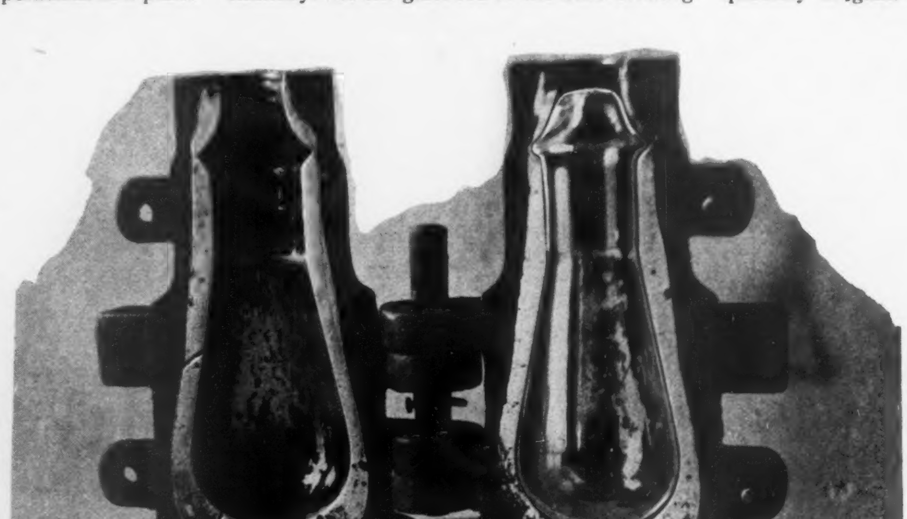
The Corning Glass Works turns out machine-blown bulbs at two of its plants—one at Central Falls, R. I., and the other at Wellsboro, Pa. We shall tell what we saw at Wellsboro, because that will help to make clear how the Corning Glass Works and others can produce in the course of a year bulbs in sufficient quantities to meet a present annual demand for more than 312,000,000 large tungsten-filament lamps—such being the volume of sales in the United States last year. This figure does not include nearly 10,000,000 large carbon-filament lamps and a matter of about 228,500,000 miniature lamps for flashlights, automobiles, and Christmas trees.

Originally, the Corning Glass Works used lead glass because it works easily and cools slowly—thus giving the blower ample time in which to fashion a bulb before the glass ceases to be plastic. That glass was melted in pots that contained enough to meet the working period of the hand blower. Today, lime glass of a special composition is employed. Lime glass sets or solidifies faster than lead glass; and it is melted in tanks capable of holding more than 110 tons in the melting end of such a furnace. The molten glass flows thence beneath a separating wall to the discharge end—the wall serving to hold back the lighter impurities and to deliver to the machines only clarified glass.

Producer gas is used to fire the tank furnaces; and of the total of sand, soda ash, lime, and cullet constituting a batch, substantially 14 per cent is volatilized and goes up the chimney. Of the glass fed to the bulb-blowing machine, 50 per cent is worked into marketable products—the other 50 per cent is wastage only so far as it becomes broken glass or cullet to be returned to the tank for remelting. In a producer-gas-fired furnace the gas from half a pound of coal will melt a pound of glass; and, starting with a cold furnace, a period of from two to three weeks is required to heat the furnace and to melt the batch so that the glass will be in a proper condition to feed to the bulb-blowing machines.

The Wellsboro plant is equipped with four such machines, which, in their entirety, are the creation of Corning Glass Works' engineers and embody radically new principles in automatic glass machinery. The capacity of one of them, the fastest in the world, is from 240 to 300 a minute, depending upon the size of the bulb being made. At 250 a minute, one of these mechanical marvels will produce 360,000 bulbs in the course of 24 hours, and work up in that time from 40 to 45 tons of glass! This helps to explain how it is possible to make the hundreds of millions of bulbs sold in this country every twelvemonth.

The machines are far too complex to describe here, and are so ponderous in appearance that they seem utterly out of keeping with the bubbles of glass they blow. Aside from what they represent in the way of engineering cunning, these machines would be ineffectual if their multiplicity of interrelated parts did not operate so as to coördinate the three essential factors of temperature, time, and air pressure. And just the required quantity of glass must be gathered to form the particular size of bulb which the machine is making. Succeeding operations have to be timed to suit the temperature changes of the cooling glass; and the air pressures used must be such that they will form the bulb but not deform it at any stage of its evolution.



Two-piece iron mold used in blowing bulbs by hand. Inner surface is coated with carbonized cork to polish the bulbs, which are rotated during blowing.

The glowing glass falls in a steady stream from an overhead outlet in the tank. Its temperature is 2,012° F. The stream passes between two rollers which form it into a flat ribbon with biscuit-like projections on the top surface. This ribbon is picked up and car-

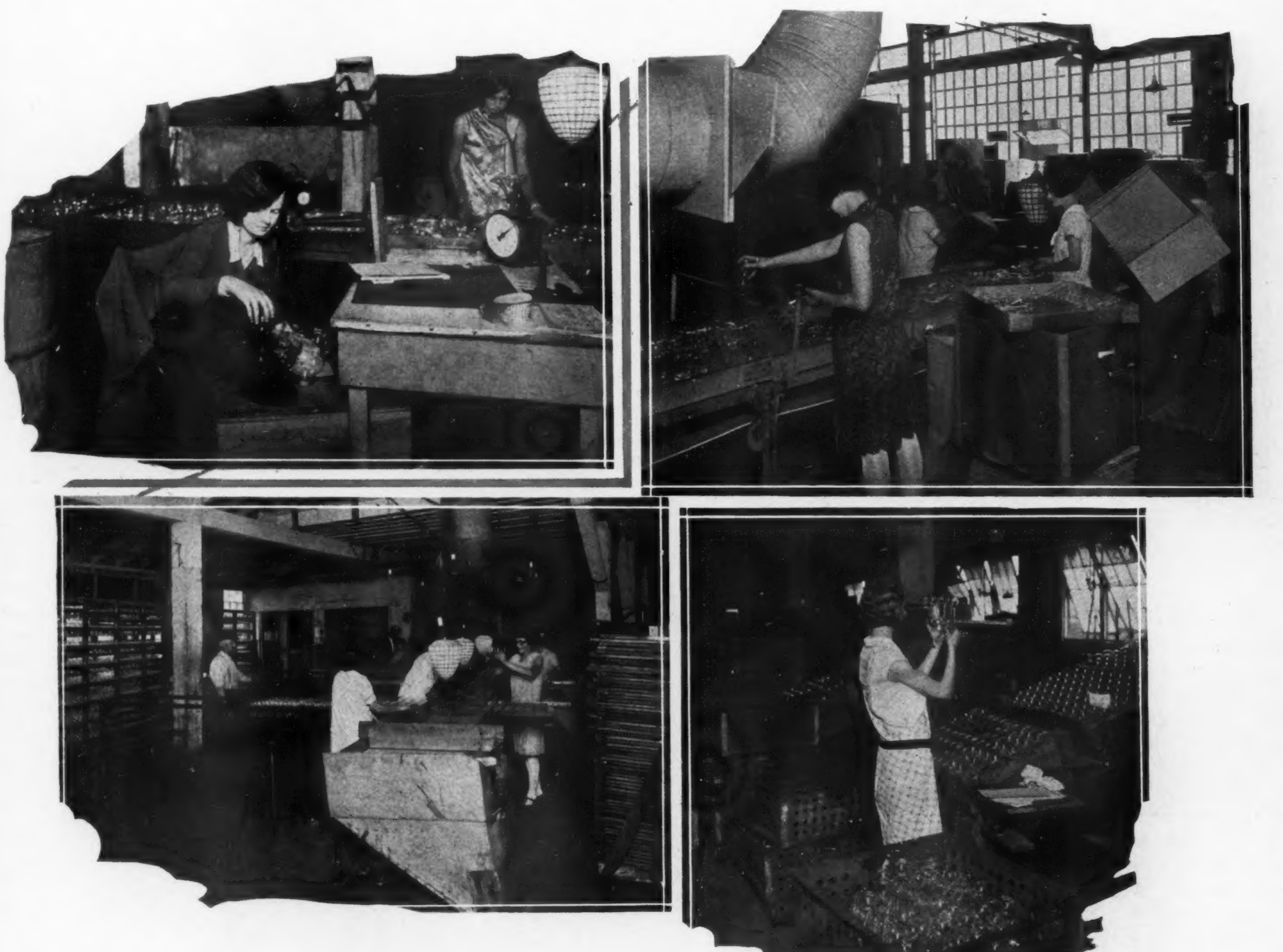
ried along by a continuous series of closely spaced and hinged iron plates in the middle of each of which is a circular hole. The mechanism is so timed that a biscuit is placed immediately over each hole, through which the plastic glass starts to sag. Next, a small descending plunger pushes some of the glass on through the hole—a connection of glass being maintained between that part which has gone through the hole and that which remains on top of the plate. Immediately thereafter a puff of compressed air forms the glass beneath the plate into a bubble as it travels onward.

carbonized cork, and the molds rotate on their vertical axes while the bulbs are within them—the coating and the rotating serving to produce polished, seamless vessels. The air pressures used range downward from 20 inches to 3 inches of water.

Before the bulbs leave the machine, the nicely regulated tap of a hollow hammer detaches them from the gathering plates—leaving the necks long enough but possibly with slightly irregular edges. In this condition the bulbs are dropped upon a conveyor that runs them past groups of burners that use

the recoating of the molds. Two machines draw glass from a single tank, and one is made ready while the other is at work. It takes but six minutes to withdraw one machine and to run the other into operating position. From 90 to 95 per cent of the machine-blown bulbs are good. Certainly a high figure considering the material used and the speed of production.

While running through the annealer, the bulbs are heated to 752° F. They then drop upon a broad asbestos belt which conveys them through a tunnel where they are cooled



Scenes in the inspection department of the Wellsboro plant of the Corning Glass Works. Top, left—Testing bulbs for weight and for diameter and thickness of necks, sides, and tops. Right—Quick "go-and-no-go" test for sizes of newly blown bulbs as they travel steadily on to the packers. Bottom, left—Every bulb is examined by nimble-fingered, sharp-eyed girls who work very quickly. Right—Expert inspectors are capable of examining a number of bulbs at one time; and it is amazing how they detect the smallest defects.

The weight of the glass and a little more air cause the gather to elongate; and just when this bubble seems about to fall, a rapidly moving open mold closes around it. A second later, a sustained puff of compressed air distends the glass and presses it against the confining walls of the mold; and this pressure is maintained until the glass has set and cooled sufficiently to become rigid. By the time this is achieved the mold swings open, and the bulb, still attached to the plate, moves forward through a stream of cooling air. The inner surfaces of the molds are coated with

butane and compressed air for fuel—the butane volatilizing from a liquid state at the low temperature of 13° F. and thus obviating any condensation in the supply line. These flaming jets fuse or smooth the raw edges of the neck and also anneal the bulb.

Each machine carries 50 split molds—all of the same size at any time. It is, however, arranged to use molds of many different sizes—the change from one size to another requiring only half an hour. A machine can be run continuously for 48 hours, but must then be withdrawn for a thorough oiling and for

with air from a large fan. On issuing from the tunnel they travel before inspectors—nimble-fingered, keen-eyed girls, and thence forward to the packers who rapidly place them in strawboard cartons. At the Wellsboro plant, one machine and a group of girl workers will make and handle as many as 134,000 bulbs during an 8-hour shift.

Every few minutes the inspectors take from the steadily flowing tide of bulbs a certain number to test them for weight, for form, and for thickness of necks, sides, and tops. Also, just once so often, they are examined through

a polariscope to ascertain the presence of strains in the glass after the bulbs are annealed; and a careful watch is likewise maintained for "fire cracks". Every hour ten bulbs are taken from each girl's lot as a further check on her alertness.

The Wellsboro plant has a frosting department. Formerly, the frosting was done on the outside and could be easily marred by scratching. Not only that, but the exterior frosting attracted and held dust. Today, the frosting is done on the inside of the bulb—a great improvement. The original objection to this was that internal frosting tended to weaken the glass; but this difficulty has been overcome by proper and successive applications of frosting acid of different strengths. The acid is sprayed into the bulbs with compressed air. The first spray is relatively strong and does most of the etching. The scond spray is weaker and is what is termed a "fortifying solution" that restores strength to the frosted bulb. Next, the bulbs are washed and then run through a drying tunnel. Cooling drafts of air make the bulbs fit to handle by the inspectors and the packers.

Every operation in the Wellsboro plant moves along smoothly and regularly. There is no hurry, because every step is nicely synchronized; and the human workers deal aptly and adequately with the tide of bulbs flowing steadily from any of the machines. One must see bulbs blown by hand to evaluate the truly astonishing performances of the bulb-blowing machine. Without apparatus of this sort the cost of incandescent lamps would today be higher than formerly instead of considerably lower. Nothing in the many-sided modern glass industry is more marvelous than this latest and most efficient of blowing machines.

Excluding the United States, there is one motor car to every 247 persons in the world. But taking that highly "motorized" country, with 1 car to each 4.87 of its population, into account, the world ratio is 61 to 1, according to figures compiled by the United States Department of Commerce.

The Corning Glass Works, at Corning, N. Y., where bulbs for incandescent lamps were first successfully made and where many thousands of bulbs are now produced daily.

DIESEL ENGINE BUILDERS ORGANIZE

DIESEL engines in power plants, in ships, for airplanes, railway locomotives, and for other automotive services, have brought about such general public interest in this type of power that the Diesel engine manufacturers of the United States have recently organized an association, known as the Diesel Engine Manufacturers Association. Twelve of the leading builders, representing substantially the entire output of Diesel engines in the United States, are members.

The objects of the Association are to coöperate in promoting the best interests of both the Diesel engine industry and the public and to serve its members in all matters relating to the industry. Special efforts will be directed towards encouraging suitable standards of manufacture and engineering practice and towards promoting and extending the use of the product made by its members.

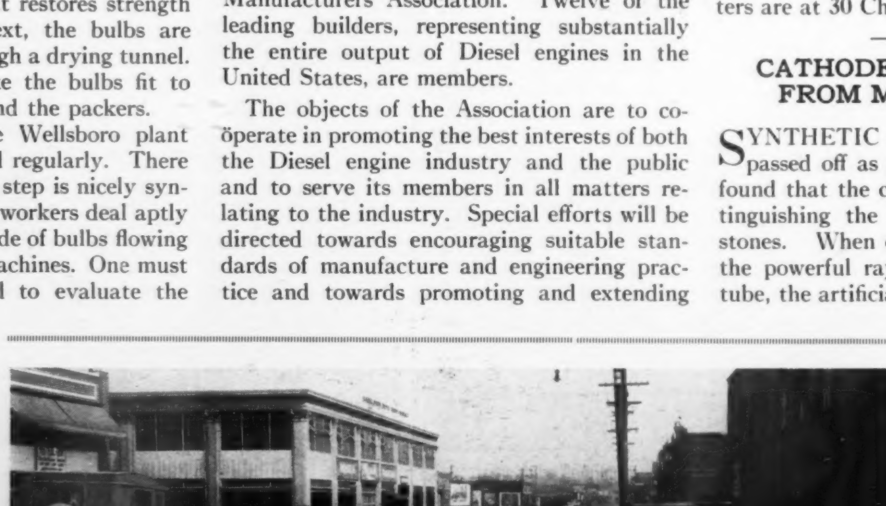
The following manufacturers are members of the Association: Busch-Sulzer Brothers Diesel Engine Company; Cooper-Bessemer Corporation; Electric Boat Company; Fairbanks, Morse & Company; Fulton Iron Works Company; Hooven, Owens, Rentschler Company; Ingersoll-Rand Company; McIntosh & Seymour Corporation; I. P. Morris & De La Vergne, Inc.; Nordberg Manufacturing Company; Winton Engine Company; and the Worthington Pump & Machinery Corporation.

The officers of the Association are: president, Henry R. Sutphen, vice-president of the Electric Boat Company; vice-president, E. T. Fishwick, vice-president of the Worthington Pump & Machinery Corporation; secretary and treasurer, Harlan A. Pratt, manager, Oil and Gas Engine Department of the Ingersoll-Rand Company. Its headquarters are at 30 Church Street, New York City.

CATHODE RAYS PICK REAL FROM MAN-MADE GEMS

SYNTHETIC sapphires can no longer be passed off as genuine, because it has been found that the cathode ray is capable of distinguishing the imitation from the natural stones. When exposed for a few seconds to the powerful ray given off by the Coolidge tube, the artificial and all but one kind of the genuine sapphires will glow as if molten. As soon as the ray is turned off, however, the precious gems lose the glow while those of man's making continue for some time to resemble live coals.

In addition to separating the real from the synthetic stones, the cathode ray also tells the investigator their source. Should sapphires from Montana, for example, be mixed with gems that are supposed to come from Australia, said D. W. St. Clair of the General Electric Company, we can discover this; and in the case of imitation sapphires we can determine which factory made them by the difference in the tone of the glow while they are under the influence of the cathode rays.



Digging a trench in the streets of Oakland, Calif., in which a 20-inch main is being laid to carrry natural gas from distant wells. The pipe line will have a total length of 200 miles. To hasten its laying through Oakland, so as to impede street traffic as little as possible, pneumatic diggers and air-driven paving breakers are being utilized extensively. The motive air is furnished by compressors mounted upon trucks for the sake of added mobility.

Concrete Piles Cast Under New High-Pressure System

By W. WALLS

IT is the purpose of this Magazine to place before its readers the many and varied uses to which compressed air is put; and this article, regarding a new "patent pressure pile", should appeal to the engineer or the contractor who, confronted with a job of pile-sinking, is called upon to decide which of the available methods will best meet existing conditions.

Hitherto, where piles have been necessary, it has generally been the practice to drive them by means of a pile hammer; and while it is not the object to go into the pros and cons of any particular system of getting them into the ground, it may be said that the use of the patent pressure pile has numerous advantages, as will be noted later.

The new method is essentially one of casting a pile *in situ* and, as the name implies, under air pressure. The principal equipment required includes an air compressor, air hoists, tripods, bore-hole casings, and boring tools of the kind commonly employed by well drillers when penetrating soft strata. The tripod, a light one of tubular construction with a "Little Tugger" hoist mounted on one of its legs, is erected over the point where the pile is to be placed. The kind of tool to be used in starting the hole depends upon the nature of the superstratum. In clay, a fairly typical example, a clay auger would be utilized to excavate to a depth of a few feet, when the first length of steel casing would be put in the hole. The bottom of this tube section is fitted with a sharpened cutting edge to facilitate penetration. The lengths that make up the pile casing are flush jointed both inside and outside, that is, free from projections that might impede downward progress, foul boring tools, or obstruct the flow of the concrete ultimately to be poured through them. The casing is of a diameter approximating the size of the finished pile.

The removal of the core is effected by means of the pneumatic hoist and a set of tools such as are used in the slip-rope system of drilling. The hoist, which is kept running continuously in one direction, has three or four coils of rope around the drum; and the operator, who holds on to the free end, alternately tightens and slips the rope, thus giving the tools a successive lift and drop—the extent of the movement depending upon the character of the ground being penetrated. The lift may vary from a few inches to a foot or so.

In this manner a shell or sludge pump, simply a cylinder with an ordinary flap valve at the lowermost end, is filled with the excavated material, hoisted to the surface, and emptied. As the core is removed with each rise and fall of the sludger, the casing sinks of its own weight. In fact, when passing through soft ground, such as sand, its downward progress is fairly rapid.

As the work of excavating proceeds, one tube section after another is added; and, with increasing depth, the contents of each cylinder withdrawn from the hole is examined to determine the nature of the material being penetrated. The information thus obtained is valuable, as it proves without a doubt whether or not a stratum of adequate bearing capacity has been reached. When a firm footing, such as clay or rock, has been struck, the sinking of the casing comes to a halt. The hole, however, is carried 2 or 3 feet deeper for the double purpose of further exploring the ground and of giving the pile an enlarged base or "club foot", as it is commonly called. With that done, suitable steel reinforcing is lowered into the casing and centered by distance pieces. Next, a pressure cap is screwed on to the top of the uppermost tube section. This pressure cap generally has three openings; one for the discharge of subsoil water and the injection of cement grout, one for the delivery of compressed air, and the third for the fitting of an air-release valve.

Subsoil water is removed by the well-known air-displacement method. That is, a pipe, about 2 inches in diameter and long enough to reach to the bottom of the excavation, is inserted in the

Top—Casing sealed and compressed air being used to clear the hole of subsoil water. The same air line is afterwards employed to inject grout into the cavity. Left—Here the successive tube lengths have penetrated to the desired depth and metal reinforcing is being lowered into the casing. Right—Site of Lloyds Bank in Southport, England, where pressure piles are being sunk to hardpan to provide the needful underpinning for the new structure.

Patent pressure pile in the course of sinking during the foundation work for the Scottish Legal Life Insurance Society's new head office in Glasgow, Scotland. Portable compressors furnished air for operating numerous "Little Tugger" hoists and for various other purposes in connection with the work.

pile casing through a sealed gland in the pressure cap. After that, air is admitted to the casing. The pressure thus exerted upon the surface of the subsoil water forces it out through the 2-inch pipe and away to drainage. In this way the hole is freed of water, which might otherwise prove harmful to the pile, and cleared of any débris preparatory to the forming of the club foot previously referred to. The cement used for this purpose is introduced under pressure, and this prevents any further seepage into the hole. With the cavity filled to a level above the bottom of the steel casing, air at 100 pounds pressure is admitted so as to compact the grout and to squeeze it tightly into every part of the hole, thus making a broad foundation for the pile presently to be cast on top of it.

The central pipe having been withdrawn in the meantime, more concrete is applied and air again admitted—the high pressure serving to force the concrete against and into the surrounding ground causing the latter to become compacted and actually to increase the diameter of the pile. The air also tends to push the casing upward—the occasional use of a lifting jack and the "Little Tugger" hoist helping to effect its withdrawal. This is done gradually, care being taken to see to it that the lowermost edge of the casing is at all times below the level of the concrete already in place in order to prevent the inflow of subsoil water. This cycle of operations is repeated until the pile is completely cast and all the tube sections have been removed. When nearing the top, however, air at lower pressure is used in placing the concrete so as not to enlarge the diameter of the pile unduly. It might be mentioned here that where a layer of softer ground is encountered in the course of the work, which is no uncommon occurrence, concrete collars are formed around the pile, and these add considerably to its load-bearing capacity. In this manner a reinforced-concrete pile—having a base several times the area of the column and compacted under a pressure of 6 tons per square foot—is cast *in situ* without jarring and under conditions that are bound to induce high skin friction.

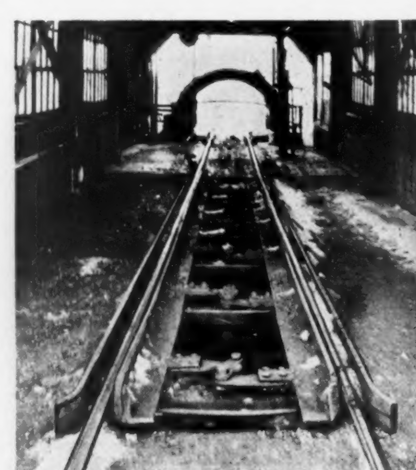
The foregoing description probably reads as though the system were easy of accomplishment; but such is not the case. Those familiar with underground drilling undoubtedly appreciate the many setbacks that may be encountered in the shape of boulders and the like in the path of the descending casing and of other mishaps that tax the ingenuity of the driller who is prepared to meet them with an array of wonderful contraptions with which he alone is familiar. Among the many advantages claimed for the patent pressure pile are:

Absence of all vibration and tremors, enabling piles to be sunk without danger to adjoining buildings; the underlying stratum in the case of each pile is thoroughly explored to assure a firm footing; each pile is cast *in situ*, making it possible to do the work in a confined space; patent pressure piling can be placed where a minimum headroom of 6 feet is available, enabling piles of any length to be sunk in basements, cellars, etc., to give added support to buildings showing signs of settlement; and piles may be given an enlarged cap, or ends may be "bent" to connect with beams or floors. They may be cast plumb or at an angle to suit special conditions.

Surveys have been completed and the route definitely established for the highway between the city of Mexico and Vera Cruz.

PNEUMATIC CAR RETARDER OF SIMPLE FORM

OUR illustration shows a positive quick-acting pneumatic car retarder conceived in the engineering department of the Berwind-White Coal Mining Company and doing effective work at the load end of the rotary dump at the company's No. 35 Mine at Windber, Pa. The car stop consists in the main of two heavy, reinforced angle irons, which serve to press the car wheels against elevated wheel guides. The gripping motion of the angle irons is imparted through toggles at the upper ends of vertical shafts carried in steel sleepers to which the wheel guides are anchored. To the lower ends of the vertical shafts are keyed stiff arms connected to the plunger of an air cylinder. When this plunger is set in motion the shafts are caused to turn, thus operating the toggles which either release or tighten the angle-iron wheel grips. The compressed air for this service is drawn from the plant's main supply system.



Courtesy, Coal Age

The quick-acting pneumatic car retarder in use at the No. 35 Mine of the Berwind-White Coal Mining Company.

Compact, truck-mounted spray-paint outfits have appeared and are finding favor especially with the railroads whose far-flung systems call for maintenance-of-way equipment that can be moved quickly from point to point where their services are needed.

Venezuela now ranks second among the world's oil-producing countries.

Official Government figures reveal that the annual per capita consumption of ice in the United States has grown from 210 pounds in 1904 to 1,020 pounds at the present time.

According to a recent survey, there are 377 skyscrapers more than twenty stories high in the United States.

What is said to be the largest clamshell bucket ever built has been shipped from the plant of the G. H. Williams Company to the Donner Steel Company, Inc., Buffalo, N. Y., where it will be used at the company's docks. From the bottom of its scoop to the top of its head, this monster bucket measures 18 feet 9 inches; and when lowered, ready for action, it has a spread of 19 feet, covering an area of 133 square feet. At one grab it is able to pick up 10 gross tons.

Story of the Donner Steel Company

In All Its Departments the Donner Steel Company, Inc., Gives Outstanding Evidence of Progressiveness

By S. G. ROBERTS

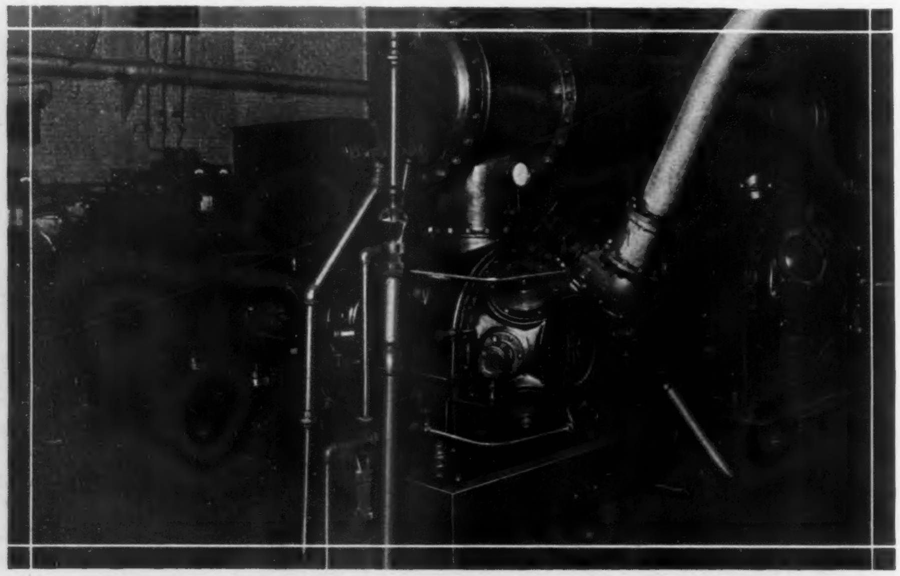
HOW much American builders of automotive vehicles depend upon the metallurgist is impressively evidenced by the demands they now make upon the country's producers of high-grade and special steels of many sorts. It has been authoritatively estimated recently that fully 20 per cent of all steel produced in the United States goes into the fabrication of automobiles, motor trucks, and other kindred vehicles; and of this volume substantially 50 per cent may properly be classed either as high-carbon or alloy steel.

Steels are today turned out for an extremely wide range of uses; and the composition of the metal is varied in accordance with the particular work expected of it in service. The average car owner is probably unaware of what is thus done to promote safety and to insure long life and excellent performance on the part of the machine driven by him or by one or more members of his family. The story of present-day steels is just one more chapter in the book of modern miracles brought to pass for the good of all of us.

The Donner Steel Company, Inc., of Buffalo, N. Y., is one of the outstanding examples of this astonishing reaction of the steel industry to the development of the automotive vehicle. This truly progressive concern has set a rapid pace in adapting its mill practices to meet current requirements that often are of an extremely exacting nature and, to a marked extent, subject to frequent changes. Resourcefulness, readiness to meet its customers' altering needs, are reflected in every department of the company's organization and also evidenced by the promptness with which newer and better methods and means are adopted whenever operating economies can be effected and improvements in the product achieved.

Perhaps a better understanding of what the Donner Steel Company, Inc., now represents can be had if we briefly summarize its industrial career. The company started in business in December of 1915 after it had purchased the property from the bondholders of the New York Steel Company. At that time the plant consisted in the main of one blast furnace, three open-hearth furnaces, and one blooming mill. During 1915-16, the company bought some adjoining land, built a dock on the waterfront, and erected a second blast furnace. It then rebuilt the three original open-hearth furnaces and constructed seven new ones. A continuous billet mill was added

Some of the four oil-electric locomotives used for many purposes about the expansive plant of the Donner Steel Company, Inc. These locomotives have supplanted "steamers", and have been instrumental in effecting substantial operating economies.



One of two electrically driven compressors which, together, furnish 5,000 cubic feet of air a minute for many services throughout the steel plant.

to the blooming mill. These improved and amplified facilities very measurably increased the company's capacity to turn out steel; but the demand for its products became such that it was necessary, between 1917 and 1919, to install a 14-inch, a 10-inch, and an 8-inch mill. During that period, the management enlarged the plant machine shop and associate shops. About the same time a roll shop was added that could turn out, from blanks, rolls for use in the company's mills. During 1926, a 14-inch die-rolling mill was provided, with a finishing department; and two years later there was erected and put in operation a cold-drawing department.

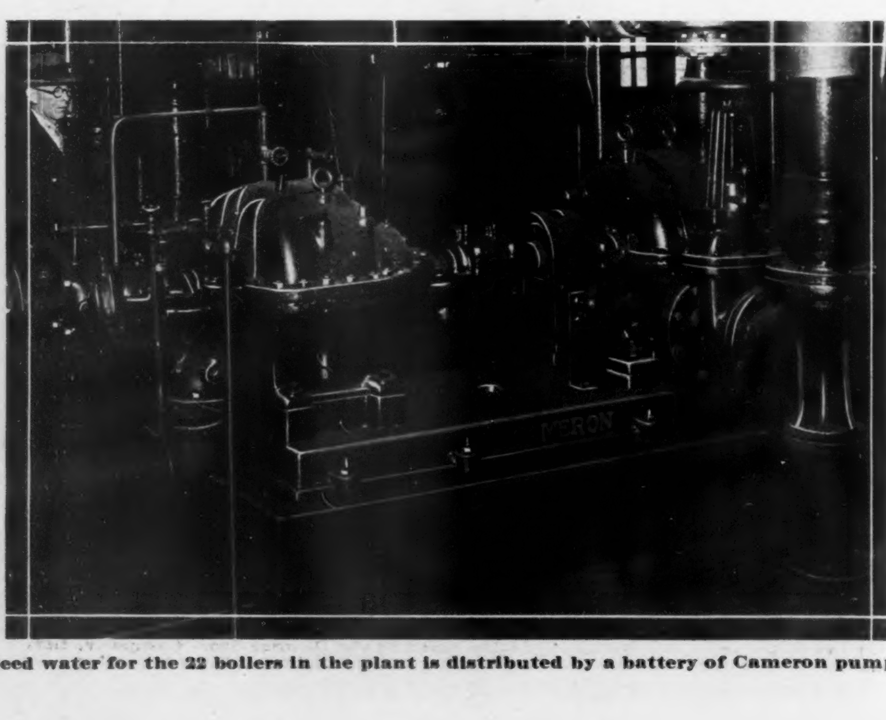
The foregoing particulars indicate in general terms the rapid manner in which the Donner plant has grown to its present estate and large enough to produce a notable volume of the superior steels used at present in the construction of automotive vehicles which call for special or superior steels for one purpose or another. The company began as recently as 1924 to manufacture alloy steels, and it did this only after demonstrating over a period of years that it was able to make high-quality carbon steels in its open-hearth furnaces. Its blooming mill was motorized a year later; and this innovation marked a long step forward in engineering practice—just one more example of the company's consistent and continual effort to keep in the forefront of the industrial procession.

In July of 1927, the company installed a large Ingersoll-Rand turbo-blower capable of furnishing 60,000 cubic feet of air at a pressure of 30 pounds to the square inch. This unit supplies air to No. 2 blast furnace, blowing 48,000 cubic feet per minute at an operating pressure of 20 pounds gage. A further improvement in plant equipment was a 25-ton Héroult electric-melting furnace, which was put in in the spring of 1928. This furnace is used especially for the production of certain alloy steels which require rather exacting control in their melting.

Since 1916, the Donner Steel Company, Inc., has been mining some of the ore it uses, which comes principally from the Mesabi Range and is moved through the Great Lakes in vessels in part owned or operated by the Donner Steamship Company. These boats have an average capacity of 10,000 tons each. The ore is discharged mechanically at the steel plant; and the ore yard is capacious enough to store 1,000,000 tons. Coke, ore, and limestone are loaded into the blast furnaces with counterbalancing skips. When the ore has been reduced from the oxide to the melted metallic state and settles to the bottom of the blast furnace, the furnace is tapped and the molten tide is directed into a mixer capable of handling 600 tons, or into what is known as a "submarine ladle", mounted on a car, which carries the iron to the pig-casting machine. The iron that goes into the mixer is drawn off in ladles handled by cranes that shift the molten metal to points for charging into any of the nine open-hearth furnaces. Now for a brief outline of the procedure followed in manufacturing steel with the aid of the molten iron produced in the blast furnaces.

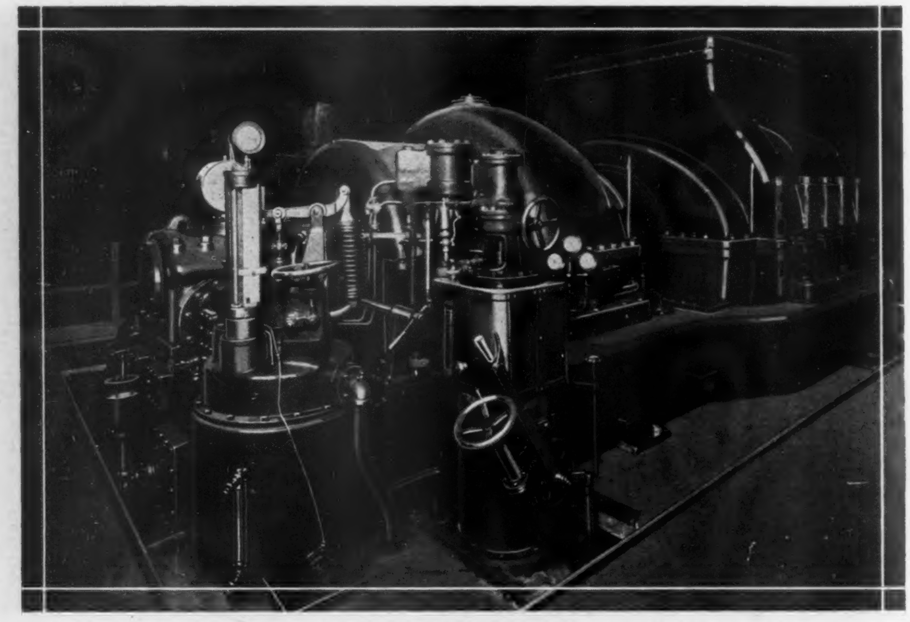
Each open-hearth furnace is good for two charges during a 24-hour period—that is to say, there is an interval of eleven hours from the time of charging to that of tapping, when the steel is drawn off and poured into molds for the casting of ingots from which the various marketable shapes or bars are rolled. An electric charging machine, that operates like a veritable robot, places in the furnaces the different materials that constitute a charge. For instance, it first delivers five buggies or carloads of limestone, which is distributed over the bottom of the furnace. Next follows a charge consisting of approximately 50 per cent steel scrap; and with this disposed of, the heating flame, using oil and gas as a fuel, is turned on. This operation continues until the scrap is heated to the point where it is just about to run. Then molten metal from the blast furnace is poured in to speed up the process of getting raw metal. In due season, the slag or melted limestone rises and carries with it certain impurities, such as phosphorus and sulphur. Excess carbon is eliminated by the heating flame. When the slag rises the melt is tested, and additional ore, etc., are poured into the open-hearth furnace as may thus be found necessary. The several operations enumerated sound simple enough, but much skill and a good deal of time are needed in turning out some of the steels manufactured by the Donner Company. For instance, high-quality alloy steels sometimes take from five to six hours to "shape up" and be fit to tap after the melt is otherwise ready. It is at this stage that the expert steelman shows his cunning and his intimate familiarity with his art.

When the open-hearth furnace is ready to



Feed water for the 22 boilers in the plant is distributed by a battery of Cameron pumps.

1—Ore and lime storage docks and ore bridge. The ore yard is capable of holding 1,000,000 tons. 2—Power shovel handling hot blast-furnace slag in a slag pit. 3—Tapping a blast furnace into a 125-ton Treadwell mixer type of ladle car. 4—The two groups of stoves that supply hot air for the blast furnaces. 5—Blast furnaces and stoves viewed from the ore dock.

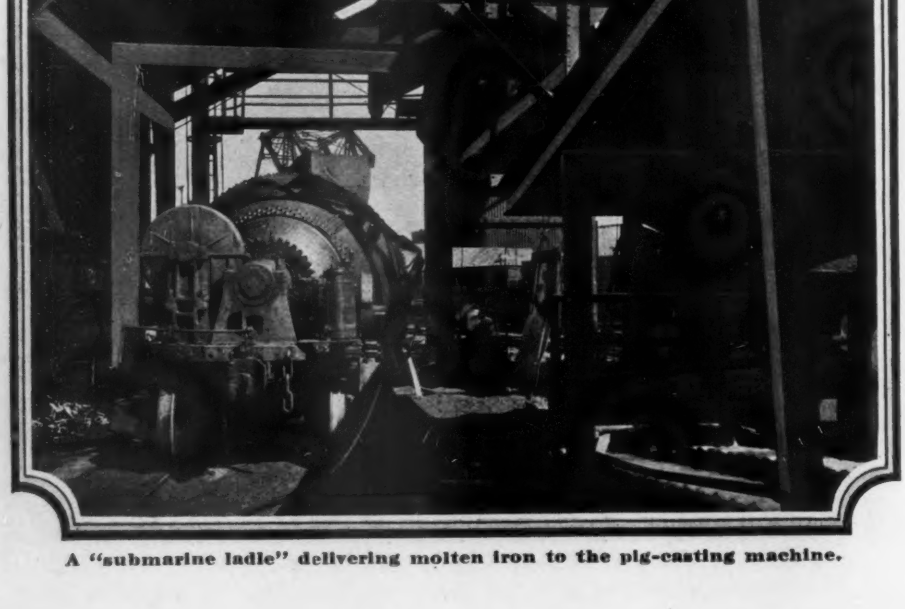


This Ingersoll-Rand turbo-blower supplies 48,000 cubic feet of air per minute, at an operating pressure of 20 pounds gage, to one of the big blast furnaces.

tap, the steel is drawn off and cast into ingots; and for some of this work special hot-top molds are used. The steels so handled are those that bring the highest prices and which otherwise would contain a much deeper pipe and therefore require the scrapping of a larger percentage of the metal. After reaching the mills, the ingots are rolled into flats, rounds, squares, and special sections.

While the Donner Steel Company, Inc., manufactures both iron and steel—the steel by the basic open-hearth and the electric-furnace processes, still the concern is primarily a producer of high-quality carbon and alloy steels that are used mainly in the automotive and allied industries. The company has been engaged in turning out high-carbon and alloy steels for about six years, and has made notably conspicuous progress in this special department of the industry. This is evidenced by the plant's continually increasing tonnage and by the lengthening list of customers that are leaders in their particular fields of manufacture.

The company makes steels of both standard and special analyses, and the latter consist largely of steels designated as chromium, nickel, nickel-chromium, chrome-vanadium, molybdenum, silico-manganese, carbon-manganese, etc., etc. The company also specializes in carbon steels of unusually high quality. Its products are blooms, billets, and bars—the bars being supplied in the hot-rolled annealed or cold-drawn condition. Special attention is given to turning out spring steel, cutlery steels, and die-rolled parts such as rear-axle shafts, propeller shafts, front-axle blanks, camshaft blanks, etc., etc. A very large volume of the company's output is used by motor-car manufacturers for such important parts as crankshafts, connecting rods, transmission gears, differential gears, steering knuckles, steering arms, bearings, etc.—in short, for the making of high-duty parts for automotive vehicles.



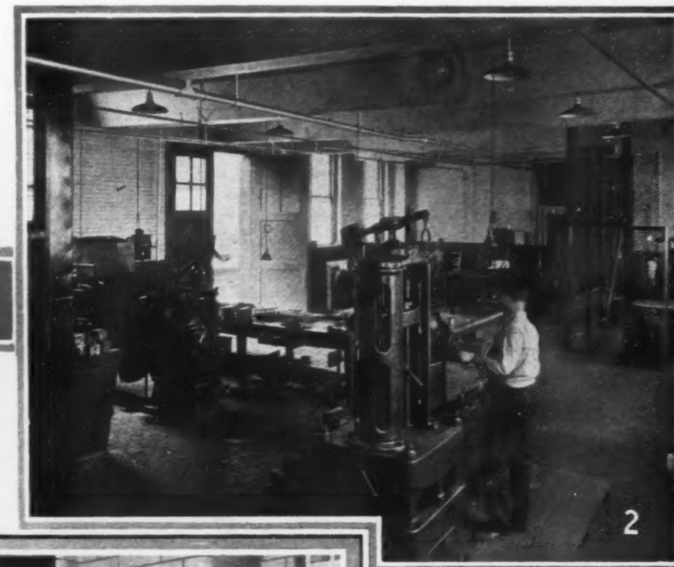
A "submarine ladle" delivering molten iron to the pig-casting machine.

The Donner plant boasts a thoroughly up-to-date metallurgical department that has at its disposal chemical and metallurgical laboratories equipped with the latest instruments, machines, and other facilities essential in selecting the raw materials and in testing the steels afterwards produced by the mills. All heats are examined microscopically for impurities and defects; and the melting formulae employed have been developed so as to insure maximum cleanliness and soundness in the marketed product. In other words, from start to finish, the steels are under the continual supervision of the skilled personnel of the metallurgical department. A research department is continually engaged in studying problems concerning the manufacture and the uses of the steels made by the company. Such subjects as control of grain size, fiber, and other physical characteristics have been gone into very thoroughly; and considerable work has been done by the experts in finding ways to produce steels that have good machining, cold-shearing, and welding properties.

Every mill is electrically driven; and 60 per cent of the current required for this purpose is generated in the plant by a 6,000-kw. turbo-generator. All steam needed for motive purposes is produced by the aid of blast-furnace gas and waste heat from the open-hearth furnaces. This typifies the operating economies that are practised wherever possible. The boilers have a total rating of 11,000 hp. The aim of the management is to dispense with the burning of coal on the property or to reduce the use of that fuel to the least extent practicable. Other fuels consumed are coke-oven gas, tar, and oil. The policy of restricting or avoiding the employment of coal explains in a measure why the Donner Steel Company, Inc., is disposing of its steam locomotives for plant hauling and substituting in their stead more efficient and more economical Ingersoll-Rand oil-electric locomotives.

The first of these oil-electric locomotives was purchased by the company on February 13, 1928; and after being in service for 5½ months, three more identical units were bought. Each machine is rated at 300 hp.; and notwithstanding the fact that they are of lower horsepower than the steam locomotives they displace, still they are doing all the work required of them. The constant torque exerted by the oil-electric locomotives largely accounts for this result; and, furthermore, they show a great saving in fuel cost and in labor and maintenance outlays. The maintenance charge is reported to be 50 per cent less than when steam locomotives were in service.

The first locomotive, during a total period of 4,416 hours, was on the job 4,017 hours—showing a 91 per cent availability. The Donner management has kept accurate records



The chemical and physical characteristics of Donner steel are the result of ceaseless vigilance. 1—Testing room of the physical laboratory. 2—A tension machine used in determining the elastic limits of different steels. 3—This microphoto machine serves to picture some of the structural characteristics of steel. 4—A torsional machine used in ascertaining the strength of steel rods subjected to certain stresses in service. 5—Another part of the testing room of the physical laboratory.

of the comparative operating costs of both steam and oil-electric locomotives, and these reveal a gross saving of 32 per cent on the entire oil-electric investment—that is, about $60 per day per locomotive; and the cost per car handled is less than half of that for similar work with the plant "steamers". The following figures covering a service period of six months for one of the 300-hp. oil-electric locomotives should be of widespread interest.

	Hours in Service	Possible Hours
May	677	744
June	643	720
July	688	744
August	706	744
September	636	720
October	667	744
Total	4,017	4,416

Oil-Electric Cost Per Hour	Steamer Cost Per Hour	Saving Per Hour
$1.38	$3.47	$2.09
1.47	3.92	2.45
1.44	4.15	2.71
1.41	3.81	2.40
1.53	4.33	2.80
1.59	4.26	2.67

With an average saving of $2.52 per hour in favor of the oil-electric locomotive, the economies effected for the half-year period tabulated amount to $10,122.84, or $20,245.68 per annum—32 per cent gross on the investment.

The Donner plant has a total of 2,400 employees; and the mills and furnaces operate continuously 24 hours a day—such being the demand for the truly excellent steels turned out by it.

PACKING GOB WITH AIR UNDER PRESSURE

THE packing of gob as it is generally practiced in coal mines is a laborious job and, unless carefully supervised, is apt to prove unsatisfactory. Wet gobbing followed hand gobbing in an effort to improve methods as well as to cut down the cost of the work; but that system, too, has its disadvantages. Now compressed air is being tried—a pneumatic packer having been developed abroad that, according to all accounts, is operating successfully and economically in the collieries in which it has been installed.

The pneumatic packer consists of a shaking trough or conveyor which delivers the gob to a receiver from which it is forcibly blown through a short length of pipe, set at right angles to the receiver, and into the cavity to be filled. The receiver with its attached tube can be readily shifted by means of a hand-operated worm gear, thus making it possible to direct the flow of the gob as desired and without changing the position of the feeding conveyor.

Practical tests have proved the machine to be capable of packing an area of 107 cubic feet per hour with small gob, not exceeding 4 inches in size, applied at a pressure of from 50 to 57 pounds per square inch. Depending upon conditions, the number of men required to do the work may vary from 2 to 4 at the tipple and from 1 to 2 at the machine; but when operating in competition with hand methods, the pneumatic packer is said to have effected savings amounting to more than $21 per gang per shift.

ROCK DUST IN COAL MINES SHOULD BE SAMPLED

THE value of rock-dusting bituminous mines so as to prevent coal-dust explosions is now generally recognized; but, states the United States Bureau of Mines, it is just as important to sample the dust periodically to get a check on its average condition.

Samples should be collected from at least one point in all entries and rooms and at distances not more than 1,000 feet apart. Road dust should be kept separate from the rib and roof or timber dust. The scoop-and-brush method as used by the Bureau lends itself well to this work which can, however, be done by any means that will provide representative samples. These should be properly identified. If this recommendation be carried out at least once a month, the full benefit of the preventive measure can be obtained.

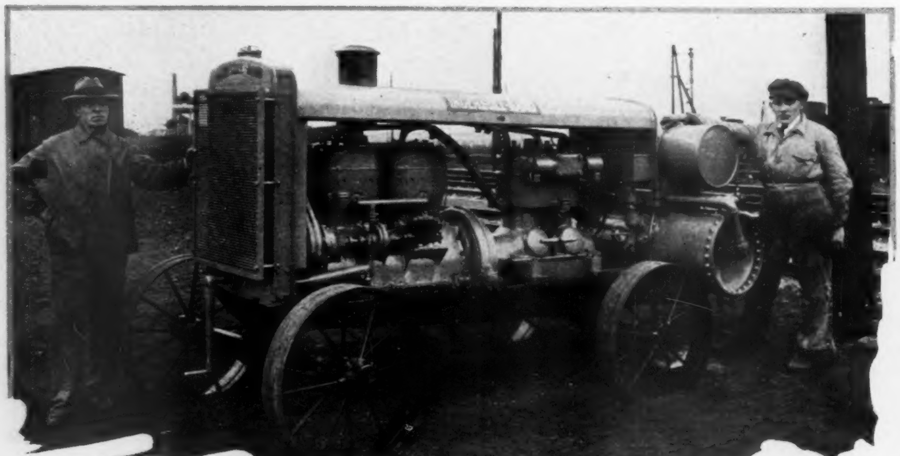
In certain parts of Africa, native tribesmen still smelt iron ore in the manner illustrated by this photograph, obtained for the Industrial Museum of the American Steel & Wire Company through the courtesy of the Morgan Construction Company of Worcester, Mass. The air blast needed to produce the heat required in reducing the iron ore is furnished by a series of goat-skin bellows operated by a circle of natives working rhythmically and probably in unison to some tribal chant. A somewhat similar procedure is followed in parts of India; and a considerable tonnage of metal is thus produced annually by means of scores of these primitive furnaces.

SOME SNAPSHOTS OF ALASKA'S SCENIC WONDERLAND

1—Picture made last June at Latouche at 1:30 a.m. 2—Mountains on Kodiak Island as they appeared to the camera at 6 a.m. during the same month. 3—Mr. Roy R. Gill with a haul of Alaska black cod made by him in Uzinki Bay. The largest of the catch weighed eighteen pounds. 4—Two humpback wales moored in Port Hobron. 5—Halibut fleet in the Harbor of Petersburg, Alaska. These photographs were taken by Mr. Gill, director of the Great Northern Railway Company.

State Railways of Czechoslovakia Adopt Latest Equipment

THE Czechoslovak Republic has an area of about 87,000 square miles—being slightly larger than the State of Utah, and within her borders there is a population of probably 16,000,000. This country, with its splendid historical background and wealth of natural or scenic charms, is industrially among the leading nations of Europe, measured by per capita output of well-directed energies. Czechoslovakia has a notably flourishing agricultural life, she is rich in well-developed mines, and her various manufacturing industries give ample evidence of the aptitude of the people in turning out products desired the world over.



This portable compressor furnished operating air for pneumatic tools demonstrated before the commission acting in behalf of the Czechoslovakian State Railways.

Czechoslovakia is an inland state that is bordered by no fewer than five other states; and from east to west she has a length of 620 miles. Because of her situation and because of the varied industrial activities of her people, the railroads of the country constitute vital arteries for the movement of commodities and for the carriage of the traveling public. To this end, Czechoslovakia has in service a total of substantially 8,390 miles of railways, and all but a small percentage of these lines is either owned or controlled by the State. Since the World War, Czechoslovakia has studiously set herself the task of rehabilitating her railroad system, and with this in view is doing everything in her power to modernize the locomotives and the freight and passenger cars, and, at the same time, to make the trackage and roadbeds equal to the best standards of railway practice. The state management has not hesitated to go abroad for guidance or example; and the reflex of this broad-minded attitude is to be seen in many directions where increased efficiency and betterments are to be found.

The accompanying illustrations give visual proof of this trend, because they indicate plainly that the Czechoslovakian railroad officials are fully alive to the benefits obtainable through the use of thoroughly modern labor-lightening pneumatic tools of one sort or another, such as are very widely employed in the maintenance of way of many of America's most progressive railroads. These tools serve both to standardize upkeep practice and to insure uniformity in the work done. Incidentally, they save time and money. These gains are of concern not only to the railway but to the shipper and to the traveler—to the shipper and to the traveler because such work well done insures speedy and safe transit. In accordance with a prearranged program, all passenger trains on main lines will be equipped with air brakes before the close of the present year.

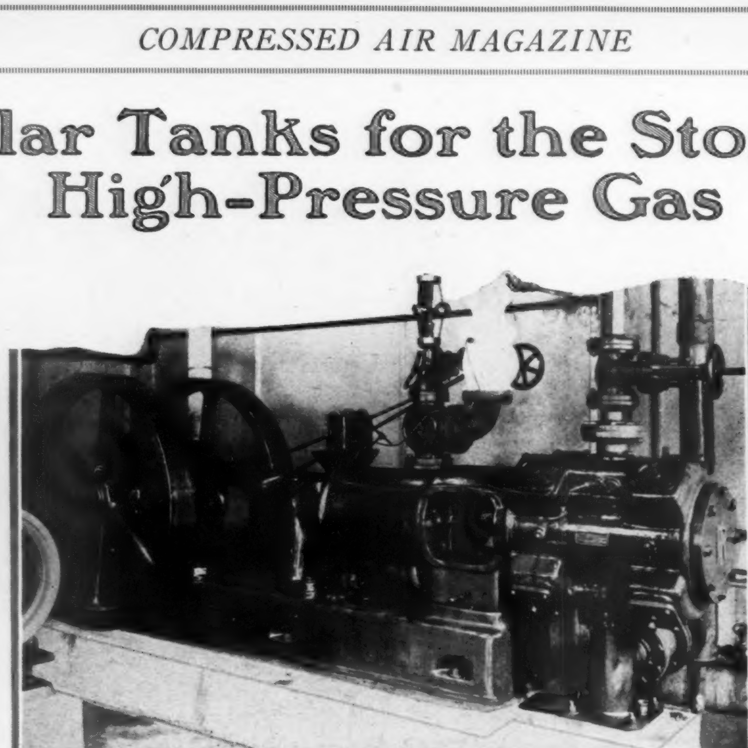
Czechoslovakia is not as well known to European tourists as it should be, and the management of the railroads is keenly alert to the part that may be played by the lines in making all sections of the country pleasurably and comfortably available to the visitor. As has been well said: The Czechoslovak Republic is indisputably one of the countries of Europe most worth seeing. All the geological periods of the earth's history are represented in the formation of her strata and contours. Elementary forces have raised there, in the heart of Europe, the highest mountains north of the Alps, and in them the natural boundaries of a territory which offers to man the greatest possibilities of development. Men made their dwellings there in prehistoric time; and in the rivalry of the sprit the people of the country have since been continually in the forefront of progress.

Government commission and officials of the Czechoslovakian State Railways considering the performances of air-driven tools developed to aid in maintenance-of-way work.

Showing the commission how different sorts of American-made air-driven tools are utilized by thoroughly up-to-date railways in the United States. The purpose was to help the commission decide which of the tools and equipment should be bought for the Czechoslovakian Railways.

Globular Tanks for the Storage of High-Pressure Gas

"NO, Sir, that is not a captive balloon making ready for ascension. It's a high-pressure gas tank." This explanation of Hortonspheres is probably made dozens of times daily the country over wherever containers of this sort attract the attention of motoring strangers. With the first question answered, the next one commonly asked is: "Why build a globular tank for the purpose instead of the cylindrical type that is so familiar?" There is a reason, in fact a number of them, for the innovation.



The Exeter Gas Light Company uses this Type FR-1 compressor to compress the gas handled by its high-pressure distribution system.

The Hortonsphere was designed primarily for the storage of liquids under pressure. It was first developed six years ago, but was not adapted to the storage of gas until 1925. These steel tanks, because of their shape, have greater storage capacity per unit of surface than tanks of other forms; and they are peculiarly suited for gas service where the distribution over widespread but not thickly settled districts must be done under high pressure in order to insure operating economies. Furthermore, it is said that the cost of gas storage per 1,000 cubic feet in standard-capacity Hortonspheres is practically uniform regardless of the size of the sphere or the pressure at which the gas is stored. Finally, the glistening spheres are pleasing to the eye, especially when set amid trees and foliage.

The Chicago Bridge & Iron Works, which build Hortonspheres in the United States, has issued a booklet containing much valuable and instructive information about these novel containers; and persons interested in these details can get a copy by asking for it. The use of storage in gas distribution is now well-nigh universal; and low-pressure systems rarely operate without storage. The outstanding advantage of high-pressure storage is that large volumes of gas can be confined in relatively small containers; and these, if necessary, can be placed economically at certain strategic points in the distributing system. For example, a Hortonsphere only 32 feet in diameter will hold, at a working pressure of 50 pounds, as much as 58,000 cubic feet of liberated gas, and the superficial area requiring a protective coating will be but 3,220 square feet. On the other hand, one of these globular tanks 60 feet in diameter will accommodate, at a working pressure of 50 pounds, a total of 385,000 cubic feet of gas; and the exterior surface will have an area of not more than 11,310 square feet. This latter item indicates a comparatively low upkeep cost.

Two of the accompanying illustrations show Hortonspheres built for the Exeter Gas Light Company of Exeter, N. H —one in Exeter and the other at Hampton Beach, not far from that town. The sphere in Exeter is $28\frac{1}{2}$ feet in diameter, and its triple-riveted seams called for the driving of 5,100 rivets. The container was erected in the course of four weeks. The shell plating is $^{17}/_{32}$ inch thick; and when charged at 65 pounds pressure, this globular tank can store 50,000 cubic feet of gas. The Hortonsphere at Hampton Beach has a diameter of $22\frac{3}{4}$ feet; its steel shell is $^{11}/_{32}$ inch thick; and 2,700 rivets were driven in assembling it. A period of two weeks was required to complete it. At a pressure of 4 atmospheres, this tank can hold 25,000 cubic feet of gas. One of our pictures shows the compressor used in charging both the Exeter and the Hampton Beach spheres. The pneumatic equipment that helped to build the tanks in question included, besides the necessary compressors, riveting hammers, buckers-up, and air drills.

As an outcome of studies of ore-crushing and grinding problems, the United States Bureau of Mines, in coöperation with the University of Utah, has developed a recording device for ball mills that accurately determines the amount of power required to crush ores to the sizes that will best lend themselves to treatment by concentration or other metallurgical processes. The apparatus is an adaptation of a recorder used by Prof. H. E. T Haultain, of the University of Toronto, for measuring the power applied to rolls; and it is sensitive enough to register as little as one thousandth of a horsepower. It is said that the device can be utilized effectually in other directions where accurate power readings may be desired.

Left—Hortonsphere erected in Exeter, N. H., for the Exeter Gas Light Company. This tank is 28 feet 6 inches in diameter and can store 50,000 cubic feet of gas when charged at a pressure of 65 pounds. Right—This Hortonsphere, also built for the Exeter Gas Light Company, is at Hampton Beach. It is 22 feet 9 inches in diameter; and at a pressure of 4 atmospheres it can hold 25,000 cubic feet of gas.

Development of the Sunrise Mine of the Colorado Fuel and Iron Company

Glory-Hole Method of Extracting Iron Ore Giving Way to Underground Mining Because of Magnitude of Pit

By C. H. VIVIAN

THE Colorado Fuel & Iron Company obtains its principal supply of iron ore from Sunrise, Wyo., which is approximately 120 miles north of Cheyenne and about 30 miles from the Wyoming-Nebraska boundary line. The ore is shipped a distance of something like 400 miles by rail to the company's steel plant, at Pueblo, Colo., which has recently been enlarged, modernized, and completely electrified.

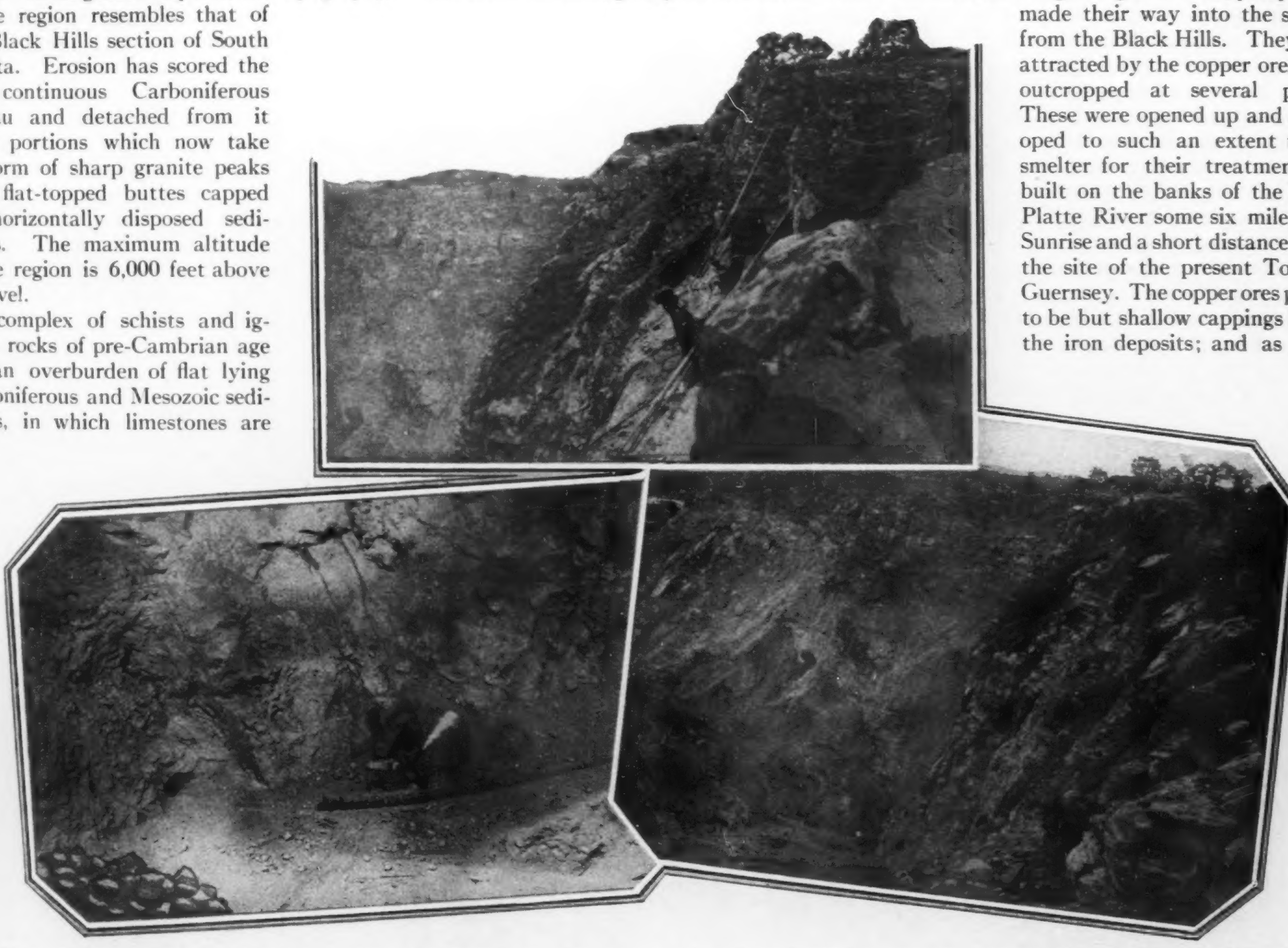
The Sunrise deposits are the largest and most important iron-ore bodies known in the Rocky Mountain region. They cover an area roughly eight miles long by three miles wide. The productive section is limited to a belt extending two miles northeastward and one mile southeastward from Sunrise.

Geologically speaking, the deposits comprise what is known as the Hartville Iron Range. In its general aspects, the topography of the region resembles that of the Black Hills section of South Dakota. Erosion has scored the once continuous Carboniferous plateau and detached from it many portions which now take the form of sharp granite peaks or of flat-topped buttes capped by horizontally disposed sediments. The maximum altitude of the region is 6,000 feet above sea level.

A complex of schists and igneous rocks of pre-Cambrian age has an overburden of flat lying Carboniferous and Mesozoic sediments, in which limestones are prominent. Following a long period of erosion, Tertiary deposits were laid down in the depressions, so that they now encircle the older rocks and partly fill the erosional valleys between them. Earth movements in bygone ages have warped the rocks into a succession of folds, the local manifestation at Sunrise being a broad synclinorium. The principal ore bodies are in the form of irregular lenses, elongated parallel to the strike of the metamorphic rocks in which they exist. These lenses range in width from a few feet to 100 feet or more, and some are 1,000 feet long. They occur principally in the schist, extending irregularly upward to the overlying Carboniferous rocks.

The ore is a hematite and is found in two forms. The first of these is a hard, gray type, containing numerous cavities which are lined with finely crystalline specular hematite. The second is a soft, greasy ore of brownish-red color. Minor quantities of limonite and siderite are present. Copper-bearing minerals occur occasionally, among them being chrysocolla, malachite, chalcocite, azurite, and native copper. The common gangue minerals are quartz, chalcedony, and kaolin. Both the hard and the soft ores grade into schist; and it is evident that they were formed through replacement of the schist. Their origin is held by geologists to be secondary, the theory being that they were concentrated by descending waters from magnetite, hematite, or pyrite present in rocks of the region —presumably in the schists.

The real discoverers of the deposits were the Indian tribes that formerly inhabited the territory. The soft, red ores fittingly served them as a war paint, and they mined such amounts as they required for that purpose. In the decade beginning with 1880, prospectors made their way into the section from the Black Hills. They were attracted by the copper ores that outcropped at several points. These were opened up and developed to such an extent that a smelter for their treatment was built on the banks of the North Platte River some six miles from Sunrise and a short distance above the site of the present Town of Guernsey. The copper ores proved to be but shallow cappings hiding the iron deposits; and as depth



Top—Men at work drilling on a steep ledge near the top of one of the side walls of the open pit. Left—Loading a string of ore cars on the floor of the open pit. Right—One corner of the deep pit from which the Colorado Fuel & Iron Company has taken many million tons of ore.

Left—An L-74 drifter at work on the third level. Right—Driving a raise from the 300-foot level with a stopehamer.

was attained, the transition to hematite was apparent. Within a few years the commercially profitable copper mineral had been exhausted, and, as there was no market for iron ore, the mines were abandoned.

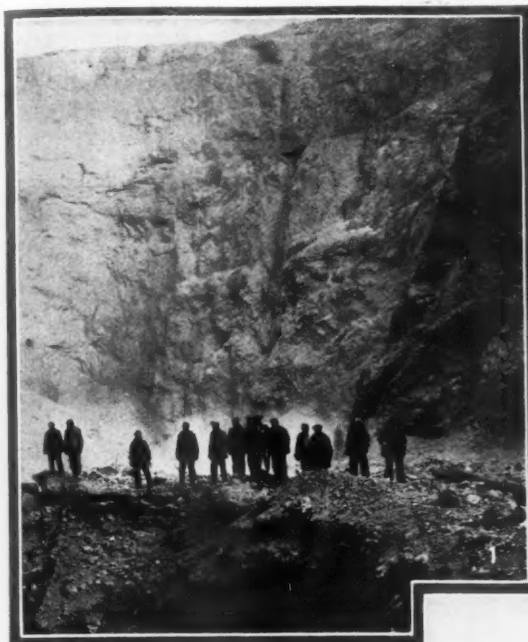
In subsequent years, during the excavating of iron ores, streaks of copper-bearing rocks have frequently been met. Little attention, however, has been paid to them—in fact, with but one exception in 1920, no attempt has been made to market them. Then a rather extensive body of very high-grade copper ore was encountered embedded in iron ore. Its discovery fortunately came at a time when copper commanded a high price; and the find contributed handsomely to the company's earnings for that year. But below the copper the ground was barren of iron ore for a considerable depth. The expense of stripping and hoisting this waste material in large part negated the returns from the surprise copper pocket.

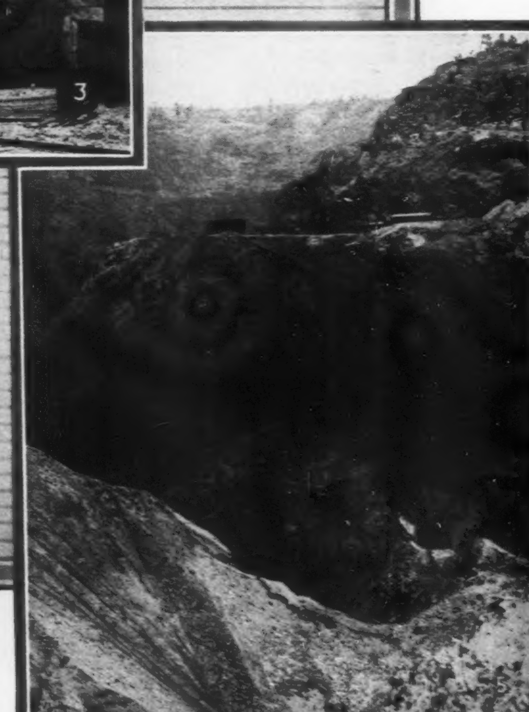
Mr. C. A. Guernsey, after whom the Town of Guernsey is named, came into the section in 1880 with a herd of cattle and spent some time there. He observed the numerous outcroppings of hematite and learned that deposits of that mineral lay underneath the copper-bearing rocks. In 1890 he chanced to be in Duluth, Minn. Upon seeing the local iron mines he realized that the Wyoming deposits would some day be of value. He returned to that western state and began acquiring claims. He was able to secure and carry to patent 1,700 acres, in the meantime also gaining control of limestone deposits which, because of their exceptional purity, have since proved highly desirable in the refining of beet sugar.

The Colorado Fuel & Iron Company was then a small but fast-growing concern. It obtained all the iron ore it needed from miscellaneous minor deposits in Colorado. By 1900, however, its demands exceeded the supply from those sources, and 1,000 acres of the Wyoming claims were purchased from Mr. Guernsey. Both buyer and seller at that time estimated the recoverable ores on the property involved to be about 500,000 tons. Actual production since then has amounted to many millions of tons; and explorations have revealed a downward continuation of the ore bodies indicating that the greater portion of them is still in the ground.

While the occurrence of the ore in lenses makes it necessary to handle and to eliminate considerable tonnages of low-grade ore and waste rock, the hematite that is shipped is of high quality. It ranges in iron content from 48 to 63 per cent, averaging around 55 per cent. The significance of these figures will be realized when it is recalled that pure hematite contains only 70 per cent of iron. The Sunrise ore is low in phosphorus and contains practically no sulphur. Its content of silica ranges up to 20 per cent.

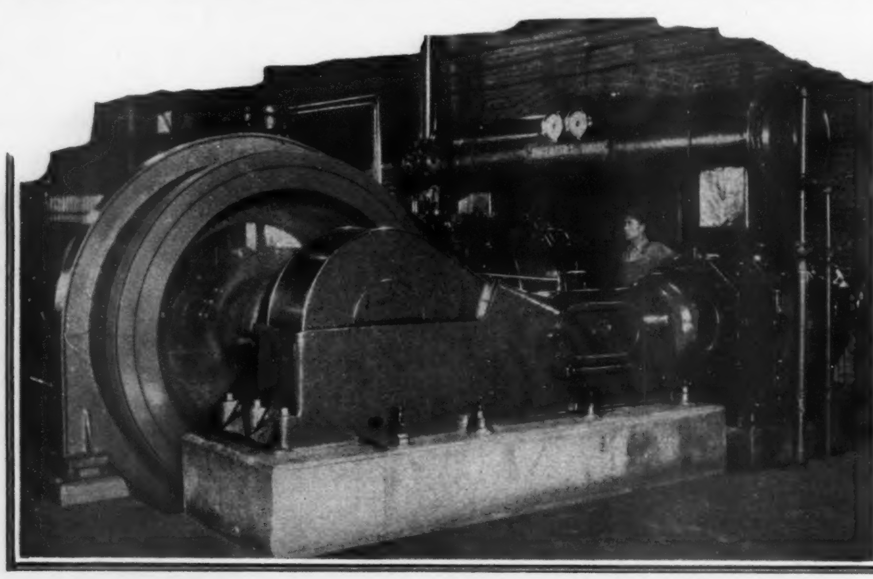
Left—The No. 5 drill-steel sharpener that has been in service in the Sunrise Mine blacksmith shop since 1915. Right—Drilling rails with a size BB reverse drill in the battery shop on the second level.





1—Miners standing on the edge of one of the glory holes in the bottom of the pit. 2—A section of the Town of Sunrise with the iron-ore workings of the Colorado Fuel & Iron Company in the background. 3—Steel headframe and loading chute of the Sunrise Mine. 4—Steam shovels are used to load the ore at the bottom of the pit. 5—Glory holes in a relatively shallow section of the pit.

The first mining operations were carried on with steam shovels—entry being made where the deposits were exposed along the sides of a small canyon. The boundaries in all directions were pretty well determined; and the ore was taken out in successive layers throughout virtually the entire area. As this process was continued through the years, the open cut was gradually transformed into a huge pit 200 feet deep, from 500 to 1,000 feet wide, and approximately 2,000 feet long.



This type PRE-2 air compressor operates on an average sixteen hours each day.

As the pit was deepened a change had to be made in the mining procedure. Accordingly, the glory-hole method was adopted, and this has been followed for a number of years. It has now progressed to the stage where the almost perpendicular side walls constitute a hazard; and the time is in sight when typical underground methods of drifting and stoping will prevail. A start has already been made in that direction. Exploratory diamond-drill holes put down at several points within the ore body were still in good-quality hematite at depths of 600 feet below the original general ground surface. Just how much deeper the mineral goes is conjectural. The known reserves are sufficient, however, to insure many more years of operation; and an extensive underground system of workings, no doubt, will be developed to procure and to handle the ore in the most efficient and economical manner.

The general plan of glory-hole mining as practiced at Sunrise is as follows: A vertical shaft, a few hundred feet back from the open pit, has been sunk to a depth of 475 feet, including the sump. Stations are cut at the 200-, 300-, and 400-foot levels. Drifts on the 300-foot level extend to various parts of the ore body—being 100 feet below the working plane at the bottom of the open pit. At suitable points along these drifts are raises leading up to the surface of the pit bottom. These openings constitute chutes through which the ore falls into the haulageways below. The bottoms of the chutes are fitted with air-operated gates for loading ore cars, which are of 2- and 3-ton capacities. These are handled in trains of ten cars each by electric locomotives.

Adjacent to the shaft are chutes extending down to the 400-foot level. The ore is dumped on to 11-inch grizzlies, from which it falls into the chutes. At the chute bottoms are pockets having air-controlled gates for loading the ore into skips that hoist it to the surface. Waste rock—which has to be handled in rather large quantities because of its occurrence between the lenses of ore—is taken out in the same manner, except that it is dumped into separate chutes opposite to the ore chutes and on the other side of the shaft. On the floor of the open pit, the side walls of the glory holes are merely broken into the openings, and gravitation does the rest. During wet weather the ore does not flow freely, and some trouble is experienced in maintaining production schedules. Fortunately, however, the semi-arid climate insures dry material as a general rule. As more and more ore is removed from around the collar of each opening, the chute assumes the form of a funnel, which is enlarged and deepened by further breaking out the material in its sloping sides. The drilling practice is to use down holes exclusively. These are put in with hand-held machines. The frequent change from hard to soft ore and the vuggy character of the hard hematite serve to complicate the drilling problem. As the holes are commonly 20 feet deep, machines of high blowing power are required to keep them free from cuttings while drilling is in progress. One of the drills satisfactorily used for this purpose is the RB-12 "Jackhamer." Its powerful, downstroke rotation enables it to fight stuck steels, while its capacity to blow hard also serves to increase its efficiency.

Hollow hexagonal steel, $\frac{3}{4}$ inch in cross section and carrying 6-point bits, is used. Holes are started with $2\frac{1}{4}$-inch bits. A 30-inch run per piece of steel is general—a 20-foot hole being finished with a bit of $1\frac{1}{2}$ inch diameter. Under the system in force, the drill runner and his helper not only put down their hole but also load and shoot it. Holes in soft material are sprung several times with dynamite, the cavities thus formed at their bottoms being loaded with black powder. The usual charge is from 8 to 12 kegs, but as many as 20 kegs have been used on occasions. As can be surmised, many tons of ore are broken out at a time.

The men who direct operations at the Sunrise Mine for the Colorado Fuel & Iron Company. Left to right: Thomas E. Finnerty, assistant superintendent; O. S. Booth, chief clerk; Thomas Tucker, superintendent; and Albert Johnson, mine foreman.

In addition to the handling of material through the glory holes, considerable quantities of ore and rock are shot down from the side walls of the open pit. Down holes are employed there also. Sometimes the working point of the drillers is a perilous perch on a ledge high above the pit floor. Dynamite is used to shoot all holes in material that does not call for springing. The rock and the ore thus shot down are loaded from the pit floor into cars by a steam shovel and trammed through haulageways to the 200-foot-shaft level.

As was mentioned before, underground mining by drift-

ing and stoping is now being carried on. For driving drifts, BBR-13 and BCR-430 "Jackhamers" and L-74 drifter drills are used on column mountings. R-51 automatic stopehamers are proving highly effective in the stoping operations, being successful in putting in 8-foot rounds despite the obstinate character of the materials drilled.

Since compressed air is an all important factor in keeping the ore coming from the mine, it is essential that a dependable air-producing plant be maintained. Further emphasis is placed on this requirement by the fact that mining operations are carried on throughout the 24 hours of the day. Obviously, reliability and efficiency are requisites of a compressor that has to work under such conditions. To meet the prevailing needs, the Colorado Fuel & Iron Company has recently installed an Ingersoll-Rand PRE-2 compressor having a piston displacement of 3,078 cubic feet per minute. This is a 2-stage machine, its 21-inch-stroke cylinders having respective diameters of 30 and 18 inches. Air is delivered at a pressure of 100 pounds per square inch.

In keeping with its well-defined policy of using modern methods, the owning company has lately electrified the Sunrise workings. Power is obtained from the Government's generating station at the new Guernsey Dam, a few miles distant. One of the outstanding electrical installations on the property is a Wellman-Seaver-Morgan hoist driven by a 500-hp. motor. Drill steels are conditioned on a No. 5 sharpener, which is one of numerous labor-saving devices in the mine's completely equipped blacksmith shop.

The shaft has two compartments with balanced skips of 6-ton capacity operating on either side. It is concreted throughout, and the station on the 400-foot level is also of concrete. The usual plan is to hoist waste rock during two shifts and ore during the third—the material being automatically dumped into bins above the car-loading tracks. Waste rock is handled in 7-cubic-yard dump cars, in which it is hauled to the dumps. Ore is shipped in standard hopper-bottom steel gondolas. The company makes connection with the Burlington Railroad system by means of its own line, which is operated over a length of several miles as the Colorado & Wyoming Railroad.

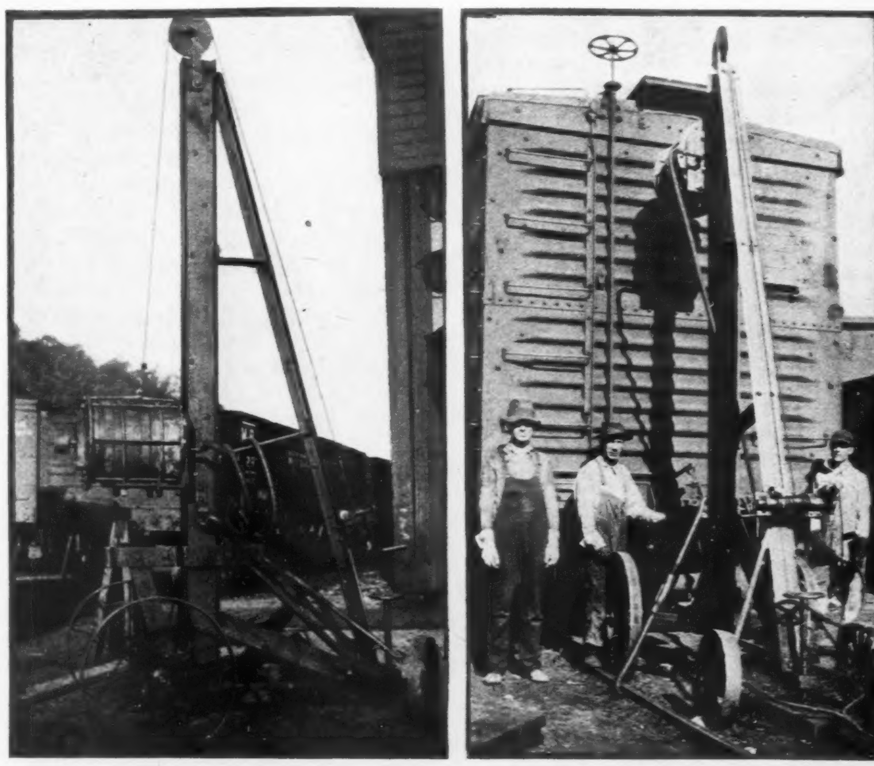
Sunrise is a progressive community numbering 2,000 inhabitants, and it is supported almost entirely by the mining operations. Among the facilities provided there by the company for the welfare and comfort of its workers is a modern building housing a branch of the Y. M. C. A.

Production from the mine is maintained at approximately 50,000 tons a month; and a force of 500 men is employed in the various plant activities. Mr. Thomas Tucker, who has been identified with the doings at Sunrise for 25 years, is the local manager for the Colorado Fuel & Iron Company.

The 1930 convention and road show of the American Road Builders' Association is to be held at Atlantic City from January 11 to 18.

STRAIGHTENING CAR ENDS WITH AIR PRESSURE

IN large car-repair shops unusual situations or problems frequently arise to tax the ingenuity of the personnel, but, more often than otherwise, the men are equal to the task. An interesting solution of a job of this class was conceived in the Kansas City shops of the Missouri Pacific Railway, where a ram, so to speak, was rigged up by P. A. Fisher, the steel-car foreman, for straightening steel-car ends that have become deformed for one reason or another. In the past, the correction of this defect has proved more or less vexatious and expensive; but now the work is done quickly and well at low cost with Mr. Fisher's air-operated portable outfit.



Courtesy, Railway Mechanical Engineer

Left—Side view of the pneumatic car-end straightener, showing essential structural details. Right—The outfit clamped to the rails and ready for action.

As our illustrations show, an 8-inch I-beam—which is sufficiently long to project slightly above the top of the highest box car—is mounted vertically on a channel bed supported on four truck wheels. The oblique member consists of two 3-inch angles tied to the I-beam with two bar strips—the entire framework being securely riveted to form a rigid unit. A 16-inch air-brake cylinder is made to slide up and down on the outside flanges of the I-beam by the use of a small hand winch secured near the bottom of the oblique member and connected to the cylinder by a flexible steel rope run over a sheave at the top of the frame. Two hinged, round, iron bars, equipped with turnbuckles, are provided to steady the frame by clamping it to the rails; and by means of a screw-and-hand wheel the load is taken from the front wheels when pressure is applied—a flexible hose connecting the cylinder with the nearest compressed-air line.

In service, the outfit is run between the rails to the car end which needs straightening. The coupler knuckle is removed from the car, and a link that is bolted to the framework is inserted in the coupler and held by the knuckle pin. After a firm connection has been thus effected, the rail-clamping rods are secured; the turnbuckles are tightened; and a block is placed under the hand-wheel screw, which is also set up. With these preparations made, the straightener is ready for operation. First the cylinder is spotted, and then pressure is transmitted by the cylinder through suitable blocking to the car end. The blocks used are made to conform to the corrugations of the pressed-steel ends of the cars so that the straightening can be done without in any way flattening those corrugations.

With air at 100 pounds pressure, the cylinder develops a pressure of approximately 10 tons; but in actual practice only enough is applied to meet requirements. As to the effectiveness of the outfit, it is said to have straightened in one month 98 steel ends on both open-top and house cars at an average cost of 2-man-hours per end, representing a man-hour saving of about 85 per cent compared with the methods previously used for the work in the Kansas City shops of the Missouri Pacific.

More than 120,000,000 pounds of black blasting powder and 353,500,000 pounds of high explosives were used in the United States and Alaska in 1928 in mining, quarrying, and railway and other construction work.

AIRPLANE CATAPULTS ON ATLANTIC LINERS

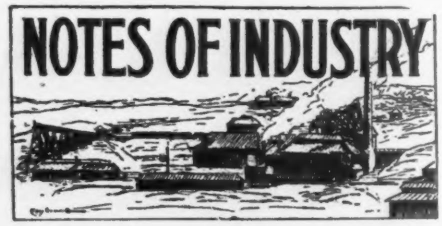
APART from the splendid transatlantic records made by the German passenger liner *Bremen* on both eastward and westward runs, the craft aroused much public interest because of her use of an air-operated catapult in launching a mail-carrying seaplane when the ship, herself, was still some distance away from her dock. In doing this, the *Bremen* was but following what had previously been achieved by the *Ile de France* of the well-known French line.

It will be recalled that the *Ile de France* first essayed, a year ago, to employ a mail plane catapulted from her deck—the flying machine leaving the steamer when the liner was about 400 miles offshore. Had the pilot not been obliged to make Boston so as to land before sundown, as required by Federal regulations, the mail would have reached New York hours sooner than it did. However, that performance demonstrated conclusively what catapults and aircraft could be counted upon to do to shorten very materially the interval between mailing a letter on one side of the Atlantic and its delivery on the other side.

The subject appeals especially to this journal because it is conversant with the invention of the airplane catapult in the United States, and has followed closely the development of this form of launching apparatus which had its first practical application aboard the larger vessels of our fighting fleet. The primary source of the energy then utilized in getting the plane off the ship was compressed air. The compressed air was employed to move a piston which, in its turn, actuated a wire cable so arranged that the piston's travel of a few feet could be multiplied a number of times at the point where the cable connected with a car or carriage mounted on a pivoted runway, The car served as the launching platform upon which rested the airplane; and the flying machine was held to the carrier and released only when it had attained sufficient speed to lift and to sustain it until its own motive power could hold it aloft.

Since the airplane catapult was first conceived by Capt. Washington I. Chambers, U.S.N., much has been done in the way of perfecting it and reducing the space occupied by it on shipboard; and the French and the German designers have, therefore, had the benefit of these developments when adapting the catapult for commerical sea service. Inevitably, the seaplane catapult will come into use for the transporting of both passengers and postal matter, because there is always a percentage of ocean travelers that will want to save time and to reach given destinations with all practicable dispatch; and they will be willing to pay for anything that will serve that end. Once more, we see how compressed air lends itself to the march of engineering progress.

The average American family spends about $28.30 a year for electricity.



Chicago is aiming to wrest from Paris the distinction of possessing the world's tallest structure—the Eiffel Tower, which rises skyward to a height of 984 feet. Plans are on foot to erect on Randolph Boulevard, overlooking Lake Michigan, a 75-story office building that will top the Eiffel Tower by 38 feet. Crane Tower, as it is to be known, will house the general offices of the Illinois Central Railroad and of the Crane Manufacturing Company; and among its outstanding features will be a garage large enough to accommodate 1,000 cars.

A Los Angeles factory is making effective use of radio apparatus in testing roller bearings. Flaws in the structure of these bearings produce sounds closely resembling static, and these sound waves are picked up, measured, and recorded by radio. Each bearing is tested against a fixed standard for sound volume while operating under a heavy load.

Ground was broken not long ago for the Grosse Isle-Amherstburg bridge—another link between Canada and the United States by way of the Detroit River.

Canada reports a 46 per cent increase in the use of electric power during the seven years ending December 31, 1927. In 1920 the consumption was 43 hp. per 100 of the Dominion's population as against 63 hp. at the end of 1927.

Since the introduction of mining machines in the coal fields of Wyoming, the average number of tons produced per man-day has been steadily mounting and in 1928 reached 6.34 tons. This, according to the United States Bureau of Mines, is apparent when the figure is compared with the average of 4.69 tons a day in 1920, when the first mining machines appeared there.

The District of London, if plans materialize, is to have an underground railway for the transportation of freight direct from the city's docks to points beneath the large wholesale and retail stores in that area. The project involves the construction of 54 public stations for the distribution of goods, which are to be conveyed thence to the surface by means of power elevators capable of accommodating suitable trucks. The cost of the undertaking is estimated at close to $195,000,000.

Santiago, Chile, will have the distinction of being the first city on the west coast of South America to build an underground railway system.

Following close upon the heels of the successful production at Taylorville, Ill., of bond paper from a combination of cornstalk and wood pulp, comes the announcement of a plan to erect a $2,000,000 pulp and paper mill in the heart of the corn belt.

According to a report just released by the Department of Commerce, a total of 50,074,450 tons of ore was treated by the flotation process in 1927 in the United States. Of this amount, 40,881,768 tons consisted of copper ores, while the remainder was made up of lead-zinc, lead, zinc, copper-iron, and other complex ores.

Since 1918, when no tax was collected on gasoline for motor-car consumption in the United States, the income from this source has reached a total of $305,000,000.

A little extra work betimes often saves a lot of trouble, if not expense, in the end. This is the attitude a coal company takes when it paints rails, stored out in the open for future use, to protect them from the attack of destructive rust. If there are many rails to be so treated the work can be done quickly either by dipping or spray-painting.

More than $500,000,000 was spent in the United States in 1928 in well-drilling operations for oil and gas. The average expenditure per well, ranging in depth between 4,000 and 7,000 feet, amounted to $22,450, as compared with $2,500 twenty years ago when a well of more than 1,000 feet was considered a deep one.

Nanking, China's new seat of government, is planning to use the ancient wall that surrounds the city in the building of an elevated boulevard for motor traffic. The roadway will have a length of 22 miles and an average width of 25 feet.

Lead mattresses between the foundations and the steel framework of tall buildings are said to be excellent shock absorbers. In one New York skyscraper about 55 tons of the metal have been used in this way.

Chemicals and allied products to the value of $2,278,000,000 are now produced annually in the United States—the industry having developed from a relatively unimportant position to one of world prominence since the beginning of the present century.

Besides being a potential source of sugar, the artichoke is said to be suitable for papermaking.

The shipment of helium from the United States Government's new production plant near Amarillo, Tex., was inaugurated with the departure for Langley Field, Va., of tank car *USQX 201* filled with about 200,000 cubic feet of that noninflammable gas. The gas is to be used in the army's lighter-than-air craft.

Compressed Air Magazine

—Founded 1896—

Devoted to the mechanical arts in general, especially to all useful applications of compressed air and to everything pneumatic.

Business and Editorial Offices:
Bowling Green Building, No. 11 Broadway, New York City
Tel. Bowling Green, 8430

Publication Office: Phillipsburg, New Jersey

TERMS OF SUBSCRIPTION

$3 a year, U. S. A., American possessions and Mexico; all other countries $3.50 a year, postage prepaid. Single copies, 35 cents. Back issues more than six months old, 75 cents each.

EDITORIALS

SPEECH AMONG THE CARIBS

IN answer to an official query as to how many languages he was familiar with, an elderly naval officer said: "Two—English, sacred and profane." Even a man of that sort would fail to measure up to the linguistic requirements of the Caribs, if a report made a short while ago by a member of the staff of the Field Museum of Natural History, Chicago, be an exact presentation of the language problem among that people.

That ethnologist is quoted by the *New York Times* as follows: "The Carib men have a language in which they speak to one another; the Carib women have a second language which they speak among themselves; and there is a third language which is used in conversation between the two sexes. The distinction between these languages is basic. It is not merely the difference between the words white men sometimes use in the smoking room as compared with those they use in the presence of the ladies. Naturally, in these circumstances, courtship among the Caribs is a highly involved matter".

Apart from the mental tax that triple speech of this sort must entail, it is self-evident that the system has much to commend it. It should cause those of either sex to be mindful of their words and make it possible for the men to talk to their masculine friends without fear of understanding on the part of members of the other sex that might happen to be within hearing. As to the language of courtship, it is generally recognized that this is different from the common tongue, be that speech what it may, so in this particular the Carib does not differ radically from his civilized fellows.

"GRAF ZEPPELIN" ENCIRCLES THE GLOBE

AS this is written, the *Graf Zeppelin* is settling to earth at Lakehurst, N. J., which that giant aircraft left 21 days, 7 hours, and 26 minutes ago on a world-circling flight. Just what this achievement represents can best be understood when it is recalled that 410 years have passed since MAGELLAN set sail from Spain similarly intent upon circumnavigating the globe. MAGELLAN was killed when he reached the Philippines on his westward voyage, but his surviving followers returned home after a venture covering a period of 2 years, 9 months, and 16 days. Such, in brief, are the extremes of man's efforts to girdle this inhabited sphere. The nearest approach to the record established by the *Graf Zeppelin* is that made by Capt. C. B. D. COLLYER and JOHN H. MEARS on their trip around the world in 23 days, 15 hours, and 8 seconds, during which they crossed the Atlantic and the Pacific on board steamships and flew the rest of the way in a monoplane.

The *Graf Zeppelin* covered 19,500 miles in the air in the course of 11 days, 23 hours, and 33 minutes. Surely a remarkable performance! She landed but three times during that voyage and met with but two trifling injuries, certainly cause for rejoicing in view of the great length and bulk of the craft. Dr. HUGO ECKENER, his crew, and all who have made the *Graf Zeppelin* possible deserve unqualified praise; and we congratulate them heartily upon the success of their work and for the courage they have displayed at every stage of the undertaking.

LONGEST ELECTRICAL TRUNK LINE

EARLY in August, a switch was thrown in one of the stations of the American Gas & Electric System that placed in service the final link in what is said to be the world's longest power-transmission line operating under a single ownership. The line stretches from the shores of Lake Michigan to the boundary separating Virginia from North Carolina—in short, the conductors cover a total distance of 980 miles and carry current of 100,000 volts. By means of interconnections with other systems, the new line joins Chicago, Ill., with Raleigh, N. C.

The line constitutes the backbone of an expansive superpower project which has been planned to serve most of Indiana, Ohio, West Virginia, Kentucky, and parts of Pennsylvania and Virginia. In addition to this main line, the system has more than 300 miles of wires carrying current of the same potential and thousands of miles of other wires transmitting current of lower voltage.

Our interest in this form of electrical development dates back to the early part of 1921 when we devoted some pages of the March issue to the presentation of a proposed superpower zone in the eastern section of the United States. As will be remembered, that pioneer scheme was suggested and advocated by WILLIAM SPENCER MURRAY, a widely known electrical engineer—the idea then being to so interconnect a number of existing independent electrical systems that they might form a distributing pool of power that would make it possible to operate their equipment at or near their maximum capacities and, at the same time, to meet the peak-load demands of more or less widely separated consuming centers. Mr. MURRAY's thought was thus to effect very substantial operating economies and to provide what he termed "the nation's workshop" with an abundance of motive energy. In a report subsequently issued by the United States Geological Survey, a very convincing array of facts and figures was presented that emphasized just what such a system would mean to the North Atlantic States.

Reluctant as some people were to accept in principle the establishment of a superpower zone in the region mentioned, still the reasons for it were so cogent and convincing that the majority of the public-service companies the country over began almost immediately to plan such developments; and the instance cited in this editorial is evidence of what is taking place in many parts of the nation today. One outstanding advantage of superpower systems is that central stations can be placed at points where physical conditions make it possible to generate power most economically—the energy then being transported long distances to places where it can be used to advantage. The general public and the purchaser of power are the beneficiaries.

LIGHT'S GOLDEN JUBILEE

ELSEWHERE in this issue we deal at some length with the fiftieth anniversary of the birth of the commercially practicable incandescent electric lamp. The story of what THOMAS A. EDISON achieved half a century ago and the record of what has flowed more or less directly from his work then constitutes one of the outstanding romances of modern industry. In order to make it possible to devise and to operate a successful electric incandescent lamp, EDISON was obliged to do several other revolutionary things equally essential to the practical working of his system of electric illumination. Unwittingly, he then laid the foundation of a vast dual public service—one that would furnish energy both for lighting and for power.

As a consequence of what he showed possible with his first carbon-filament lamp on October 21, 1879, there has grown into being in the United States a light-and-power industry which represents today an invested capital amounting to more than $8,000,000 000! And in place of candles, oil lamps, and gas jets, we have at our disposal electric illumination which, measured only by the radiance of all the large tungsten-filament lamps sold in this country last year, aggregates 247,500,000,000 lumens. Were all this light focused upon a city from a suitable point in the sky, the intensity of that illumination would be equal to the brilliancy of our noonday sun multiplied several times! This present climax becomes all the more

astonishing when it is recalled that most of EDISON's coworkers were frankly skeptical about this first lamp, and freely prophesied that it probably would not last for more than a few minutes at the most—certainly not for substantially two days, as it did, during which it burned steadily and brightly.

One of EDISON's problems was to obtain glass bulbs with very thin walls for his incandescent lamps. He knew that he would have to have something that had not previously been made by glass blowers on a commercial scale. Our story tells where and how he obtained the desired bulbs in those early days, and it also recounts how the manufacture of the bulbs has evolved in the meanwhile. While a considerable percentage of electric-light bulbs is still hand blown, by far the greater number is produced by machinery. These blowing machines are really marvelous units, and the largest and fastest of them can turn out as many as 300 bulbs a minute. From the time the molten glass is drawn from the furnace until the bulb is delivered to the inspectors and packers, every indispensable operation is performed in its ordered sequence by machinery. This largely explains why the ultimate consumer is able to obtain his incandescent electric lamps at the really moderate price he has to pay for them. The bulb-blowing machine is just one more example of the wizardry of present-day engineering.

MULTIPLYING MOTOR CARS

DURING the first seven months of the current year our motor-vehicle factories produced 3,723,723 cars; and it is authoritatively estimated that the output for the whole year will amount to 5,200,00 automobiles. These figures are impressive evidence of what the industry is doing and the proportions it has assumed in the comparatively short span of its existence. However, we get a still more vivid picture of what the advance means when we recall that one of the officials of the Automotive Division of the United States Department of Commerce recently declared that there are "enough motor cars in our country to move bodily, at the same time, every man, woman, and child".

To such of us as are keenly alive to the uncertain performances of the first of our motor cars, and can remember how few and far between they were as they commingled with horse-drawn vehicles, the present numbers in service give evidence of a really amazing development. What also helps to a keener realization of what has happened in this field of manufacture is the fact that for years after the automobile came into being the mechanically best and the finest appearing of the machines were products of European makers. This situation no longer prevails; and American cars can hold their own the world over because of the skill exercised in their manufacture and the good taste and art displayed in their designing.

It is a matter of common knowledge that our factories are turning out for export a steadily increasing number of cars; and it has been estimated that fully 18 per cent of the 1929 output will be exported. In no other direction is our engineering resourcefulness and our manufacturing ability displayed more strikingly than in the motor-vehicle industry. And a vast deal of the success of this department of industry is due to the way in which the foremost of the plants are organized and mechanically equipped to turn out superior work with productive personnels having little if any previous training.

ACKNOWLEDGMENT

Through an oversight the credit line, *Resk Studio, New York*, was omitted beneath the photograph of the late George Thomas Cousins appearing on page 2844 of the August issue of this Magazine.

OPALS AND GOLD, by Robert M. Macdonald, F.R.S.G.S. An illustrated book of 256 pages, published by J.B. Lippincott Company, Philadelphia, Pa. Price, $4.00.

THE author, in this entertaining volume, has told of his colorful experiences as a prospector in roaming far and wide in quest of mineral riches of varied sorts. He has sought gold, opals, pearls, and mineral wealth in widely diversified forms; and no small part of the pleasure his recital gives is due to the fact that he carries us to unfamiliar sections of the inhabited globe. There are recurrent characters that appear from time to time in the story, and each of these is a character with a distinctive personality. The book makes pleasant and informative reading.

THE STORY OF THE BALTIMORE & OHIO RAILROAD, by Edward Hungerford. A profusely illustrated work of two volumes, each of more than 360 pages, published by G. E. Putnam's Sons, New York City. Price, $10.00.

THE inspiration for this record is the fact that the Baltimore & Ohio Railroad began serving the people of this country in 1827 and has been so occupied with increasing social and economic effect ever since. From a modest beginning, and within a very much circumscribed area, this notable trunkline has steadfastly reached out farther and farther in its efforts to be of greater help to the country through which its main and branch lines run. Indeed, the evolution of the Baltimore & Ohio is just another expression of the material progress of the United States as a whole. The annals of this splendid system make absorbing reading; and in the pages we have vivid pictures of the difficulties met and surmounted and of the able men that contributed in differing degrees to these epochal accomplishments. Mr. Hungerford has done a characteristically fine thing in his treatment of the subject. The American people at large should have a fuller knowledge of what the Baltimore & Ohio Railroad typifies. The present volumes are a treasure house of information upon this topic.

ENGLISH-RUSSIAN MINING AND METALLURGICAL GLOSSARY, by N. I. Truschkoff. A volume of 141 pages, published by Kubuch, Leningrad. Price, 2 rubles 75 kopecks.

THIS helpful handbook is the product of a professor of mining in Leningrad Mining Institute who, because of his professional standing is qualified to compile a glossary of mining and metallurgical terms. Inasmuch as most foreigners find the Russian tongue too much for them, the volume prepared by Professor Truschkoff should prove of much value to English-speaking people who may wish to have dealings with Russians in matters having to do with mining and metallurgy. There is a steadily increasing demand for aids that will promote and facilitate intercourse in these departments of industry.

TELEVISION, by H. Horton Sheldon, Ph.D., and Edgar Norman Grisewood, M.A. An illustrated work of 194 pages, published by D. Van Nostrand Company, Inc., New York City. Price, $2.75.

AS indicated by a sub-title, this volume is designed to deal with the present methods of picture transmission by television. The authors are fully alive to the fact that they are dealing with an art that is both in its infancy and in a state of rapid flux; and in evidence of this they admit that the work was faced with a prospect of revision before leaving the press. It is undoubtedly true that advances have been made since the co-authors started the preparation of their text; and additional progress has been achieved since it became available to the public. However, there are certain fundamentals associated with the subject that will remain fairly constant for some time to come; and a knowledge of these will help us not only to grasp what has been done to date but to make it easier for us to comprehend developments and the general trend of this fascinating departure in the distant transmission of images and active scenes.

STEAM, AIR, AND GAS POWER, by William H. Severns and Howard E. Degler, members of the staff of the University of Illinois. An illustrated volume of 425 pages, published by John Wiley & Sons, Inc., New York and London. Price, $4.00.

THE book has been prepared as an elementary text for use in courses dealing with heat engineering and, primarily, for students taking only a single course. The aim has been to describe briefly and clearly typical and representative equipment, and to explain the theory of such machines and devices. The mathematical calculations involved are of the simplest order, and illustrative problems have been included wherever necessary. We believe the book will amply justify the efforts of its authors and its publisher.

Buyer's Guide Nickel-Alloy Products can be had gratis upon application to the International Nickel Company, Inc., New York City.

The Boiler House in the Oil Refinery is the title of a pamphlet issued by the Combustion Engineering Corporation, New York City. Copies can be obtained free upon request.

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